Product Engineering

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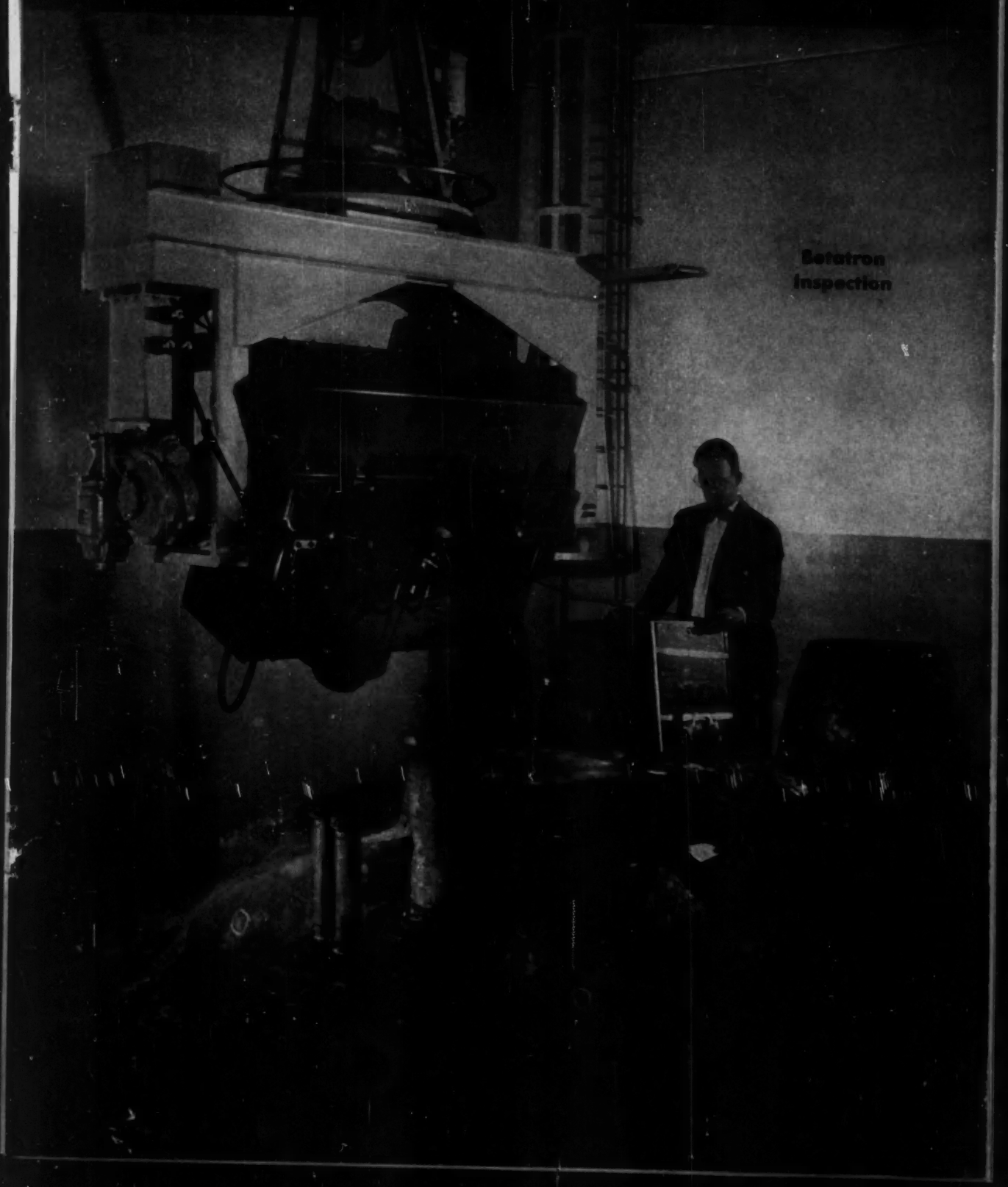
JUNE 1953



Betatron Inspection

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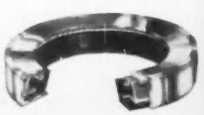

75 C/R FIFTH ANNIVERSARY

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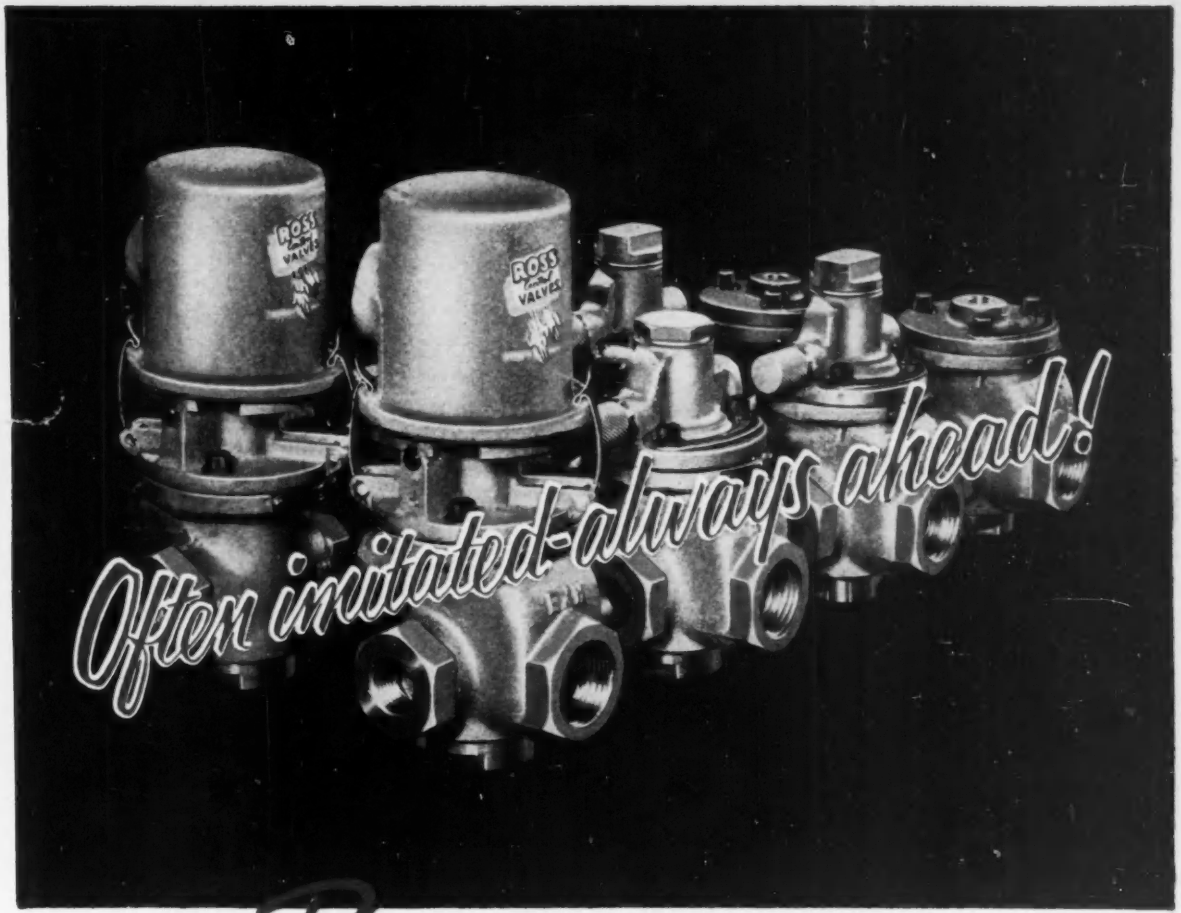

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Product Engineering

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ABP June, 1953 **Product Engineering** Vol. 24, No. 6 ABC

A McGRAW-HILL PUBLICATION

Member of Associated Business Publications and Audit Bureau of Circulations

Published monthly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. Publication office, 99-129 North Broadway, Albany 1, N. Y. Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42nd St., New York 36, N. Y. Curtis W. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Senior Vice-President, Publications Division; Ralph B. Smith, Vice-President, Editorial Director; Nelson Bond, Vice-President, Director of Advertising; J. E. Blackburn, Jr., Vice-President, Circulation.

Subscriptions: Product Engineering—Subscription Service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address.

Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Position and company connection must be indicated on subscription orders.

Single copies 50c. United States and possessions, $5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $10 for two years, $12 for three years; Latin American countries, $15 for one year, $25 for two years, $30 for three years; all other countries $25 for one year, $40 for two years, $50 for three years. Entered as second class matter Aug. 31, 1936, Albany, N. Y. Post Office, under act of Mar. 3, 1879. Printed in U. S. A. Copyright 1953 by McGraw-Hill Publishing Co., Inc.—All rights reserved.

Number of copies printed this issue 26,935

THIS MONTH'S COVER

Allis Chalmers 22 million volt betatron set up to radiograph a steam turbine cylinder ranging in thickness from 6 to 18 in. Accurate location of flaws, even as narrow as a few thousandths of an inch, in sections having a thickness variation as high as 50 percent, is possible on a single film. Kodachrome by Mike Durante, Allis Chalmers Photographic Department.

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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear.

NONMETALLIC MATERIALS

SOME SUCCESS in the control of ultraviolet and infrared rays have been reported for a thermoplastic. The material is a spray on plastic film and a sheet plastic produced by the Eastern Industrial Service, Inc., Cambridge, Massachusetts. Laboratory and factory tests show that the product will filter out 95 percent of the ultra-violet rays and reduce transmission of the infrared rays up to 80 percent.

LATEST USE for plastic is as the core of wire rope. The plastic core replaces the fiber core normally used. Jones and Laughlin Steel Corp., Pittsburgh, Pennsylvania, reports that the plastic core wire rope is not affected by acids, caustics and other sub-surface substances in drilling of oil and gas wells. The plastic core will not be affected by lack of moisture during storage or excessive moisture during use.

LOW MELTING POINT bismuth alloys are being used to anchor bearings, bushings, and non-moving parts in manufactured items, Cerro de Pasco, N.Y., N.Y., reports that an accurately located bearing can be accomplished with a fixture and by pouring an expanding alloy into the space between the bearing and the oversized cored hole provided in the casting. This eliminates all expensive machining for press or drive fits.

FUSED QUARTZ, because of its low radio activity, is finding important uses in various Atomic Energy installations. Hanovia Chemical and Manufacturing Co, Newark, N.J., states that fused quartz is a pure silicon dioxide as compared with all other glasses which are compounds. Its qualities compare favorably with the other materials. These materials are not inert under various thermal stresses, or because of their nature, change shape due to position.

SILICONE MATERIAL can now be used as a weld-backing compound. When thinned to a fluid paste consistency, the material can be painted on joints before welding. General Electric Co., Schenectady, N.Y. reports that it allows uniform weld penetration and eliminates the harmful effects of air on the underside of the weld. As it allows no carbon pickup in the weld, it can be used for welding low carbon steels.

A COMPLETELY synthetic lubricant for use in jet engines that possesses a combination of properties said to be unobtainable in a single mineral oil is in pilot plant stage production. Standard Oil of New Jersey (Esso) states that EATO 15 will not solidify at -65 F, and when heated to 450 F. the oil resisted altitudes of 80,000 ft before boiling. The best light mineral oil began to boil at 40,000 ft. The lubricant has a viscosity of 15 centistokes at 100 Fahreinheit.

METALLIC MATERIALS

POROUS NICKEL sheet for aircraft housing of instruments and avionic gear prevents the entrance of moisture but allows rapid equalization of air pressures. According to Micro Metallic Corp., Glen Cove, N.Y., the sheet is silicone treated for water repellency and will not pass water if the differential is less than 3 psi.

LONG RANGE research program has developed a corrosion resistant steel that withstands attacks of acids and alkalis, both reducing and oxidizing. Haynes Stellite Co, calls the alloy Hastelloy F, and it is a mixture of nickel, molybdenum, chromium, and iron. It is reported to have a density comparable to nickel base alloys, electrical resistance slightly higher than 18-8 and thermal expansion characteristics about 10 percent lower. It is nonmagnetic.

A COPPER CLAD STEEL composed of medium carbon steel with thin layers of electrolytic copper clad to one or both sides, is claimed to have good conductivity, excellent ductility, and retains good spring properties after heat treatment. Developed by the General Plate Div, Metals and Controls Corp, the electrical conductivity properties can be varied by changes in the copper layer thickness. A 10-80-10 thickness ratio gives a conductivity of about 30 percent when compared with solid copper.

(continued on page 7)

Hold your answer! We've got three more questions. Can your part be moulded by thermosetting methods? Can it be moulded with standard thermosetting materials or newer materials like Teflon, Alkyd or glass-reinforced plastics? Do you need quick deliveries in production quantities? Three "yes" answers, and your part problem's solved. We're custom moulders for *any* thermosetting job—with complete moulding facilities, including design and mould making. Phone or write *your* questions to Dayton or your local branch office.

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Highlights ~

CASTING POTENTIALS is a new project of the Air Materiel Command at Wright-Patterson Field, Ohio. The project is to determine the extent to which castings can replace more expensively fabricated parts. Several studies are underway, such as casting the wings of the F-94 in one piece and the possibility of casting a 16 ft wing section of exacting tolerance from magnesium alloy. Also, the development of magnesium casting alloys for replacing steel in medium temperature applications. Another study now in the development stage is the production of aluminum airframe castings capable of withstanding pressures of 70,000 lb per sq inch.

THE PROBLEM of brazing and soldering of aluminum and its alloys is undergoing a two-fold study. One is better fluxes, and the Mathieson Chemical Corp, has come up with Hydrazine which appears excellent. The second, better soldering alloys, is being studied at Battelle Memorial Institute under a research contract.

NONCRITICAL metal containing 16 percent aluminum and 84 percent iron has good magnetic characteristics. Developed by the Naval Ordnance laboratory and called 16-Afenol, the magnetic properties will make it useful in transformer cores and high frequency equipment.

A MIRROR BRIGHT FINISH and good adherence to steel is promised for a zinc-iron alloy coating. Developed by the British Iron and Steel Research Association, the coating of 5 percent zinc and 95 percent iron, is reported corrosion resistant and may be a substitute for nickel prior to chromium plating. Alloy coatings with more zinc have better corrosion resistance but are not as bright as the developed coating.

COMPONENTS

MAGNESIUM FOR BATTERIES is one of the newer uses for this light material. Dow Chemical Co, Midland, Michigan reports that this use is still in the pilot plant stage but is expected to be a major magnesium outlet in the future. Magnesium batteries will have a lighter weight and an increased capacity as compared to zinc. Another outlet is photoengraving where magnesium is used as plates for direct printing.

A LIGHT WEIGHT temperature-proof electric cable is being perfected and field tested at the Signal Corps Engineering Lab, Fort Monmouth, N.J. The cable is claimed to be 30 percent lighter in weight, 15 percent smaller in diameter, and can withstand 650 lb loads. It is unaffected by temperatures between -67 and +140 F. An 18-8 braided case reduces transmission losses.

A LOOSENING of aircraft component tolerances may be announced in the near future. Studies of a Russian MiG fighter by the Air Force showed that wider tolerances found in the jet does not hamper performance. Feeling is that more planes could be built cheaper and faster.

PRECISE TEMPERATURE CONTROL and overheat detection where minimum volume and weight are important can be accomplished with an ultra small thermo switch. Fenwal Inc., Ashland, Massachusetts, reports the switch can be used in instruments and precision mechanisms where high resistance to vibration is needed.

USEFUL AMOUNTS of electric energy have been obtained from nuclear energy released from a new type of liquid reactor. Union Carbide and Carbon Corp., reports that its scientists brought a pilot model of the reactor system to its fully-designed power of 1,000 kw of heat output. The reactor is a homogenous solution that serves as fuel moderator and coolant. Heat generated by the reaction of uranium fuel is removed by pumping through a heat exchanger which gives steam to drive a turbine generator.

PROCESSES

GLASS is being used to lubricate steel for extrusion into long rods, pipes, and other shapes. Vanadium Corporation of America, reports that the use of glass lubricants allows the extruding temperature to reach 2,300 F but that the die temperature is never greater than 600 F, thus allowing the die to be used indefinitely. The glass is removed from the extruded shape by a quick dip in hydrofluoric acid.

CONTINUOUS VACUUM MELTING furnace for titanium, zirconium, and molybdenum should give metals of excellent physical, chemical, and electrical properties. National Research Corp., Cambridge, Mass, states that it is possible to charge raw material and remove cast ingots from furnaces without the cooling of the crucible or breaking the vacuum in the melting chamber.

(continued on page 9)

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Highlights ~

INDUCTION SILVER BRAZING of titanium and its alloys to any of the commonly used steels or nonferrous metals can be accomplished. In the process, however, quick, local uniform heating must be achieved in an inert gas atmosphere and the part must be cooled at a moderate rate. The process uses, according to North American Aviation Inc, Downey, California, a focus-inductor work coil for uniform heating. An evacuated bell jar that is flushed out with an inert gas provides the inert atmosphere for the brazing operation. Water cooling the work coil prevents the coil from melting and cools the welded joint. The best and strongest joints are obtained with pure silver as the brazing metal.

COLD GR-S synthetic rubber now can be made in about 20 minutes compared with 12 to 14 hr. production rates previously used. Naugatuck Chemical Div. U. S. Rubber Co. reports the pilot plant operation speed is achieved with fast-acting formulas and heat-exchanger that dissipates heat formed during the reaction.

PILOT PLANT operation of a new process for the recovery of iron from low-grade, taconite iron ore has proved successful. Battelle Memorial Institute reports the process-known as the reduction-oxidation process for the treatment of nonmagnetic taconites - reduces the amount of initial heat required and allows it to be reused. This point is the one that has made other methods economically unfeasible.

TESTING

A DIRECT READING spectrometer is helping to speed metal quality testing by cutting time from 4 hours to 5 minutes. Baird Associates built the spectrometer to Fairchild Aircraft Div., Hagerstown, Maryland, specification, and it can handle metals having 5 different bases - aluminum, brass, stainless, magnesium, and low alloy steels. The instrument analyzes metal samples and provides instantaneous dial readings on the percentage of each element in the metal.

ALUMINUM WINDINGS, with overall weight, dimensions and electrical characteristics, that are practically identical with those of copper are being tested on GE transformers. These units are rated at 5 to 333 kva for voltages of 15,000 or less. Several units are operating to get field experience and data.

A BALANCING MACHINE has been developed that will detect displacements of 0.00004 in. from a center of gravity. The Cosa Corp, N. Y. claims it can show the amount and location of dynamic and static unbalance in rotating parts weighing from a few ounces to over 100 tons. It uses a watt meter with electrical measuring that uses no electronic tubes or oscillographs.

CORROSION of titanium and other metals have been undergoing studies at the U. S. Naval Engineering Experiment Station, Annapolis, Maryland. Titanium in natural sea water flowing at a velocity of 2 to 4 fps had a weight change that was hardly detectable. Monel and stainless type 304 coupled to titanium showed no effects of galvanic action; however, bonze coupled to titanium showed strong effects of galvanic corrosion. Cupro-nickel tube also corroded.

INVESTIGATIONS indicate that boron or cobalt is steel have an adverse effect on oxidation resistance at temperatures over 1650 F. Electro Metallurgical Co., N. Y., reports that chromium and nickel have a benefical effect while molybdenum decreased the alloys oxidation resistance. Solution seems to be the production of boron alloys with no-boron oxidation resistance by keeping the iron content below 6 percent and the use of W rather than Mo for strength.

FURTHER STUDIES of ultrasonic methods to the solution of metallurgical problems is being made possible by new equipment using magnetostriction transducers. Mullard, Ltd., England, reports that ultrasonic waves will facilitate the application of metallic coatings to other metals, such as the coating of steel with aluminum. Ultrasonic methods lower the surface tension and allows a smoother flow of aluminum over the surface. The ultrasonic waves can also promote grain refinement of aluminum alloy castings and degas molten metals.

INVESTIGATION of radio noise caused by antifriction bearings in rotating equipment can be minimized by use of a low viscosity lubricant. Naval Research Laboratory reports that light petroleum oil or grease is best; however, in the design of new equipment insulating sleeves and bushings, or shafts of nonconducting material should be used wherever possible.

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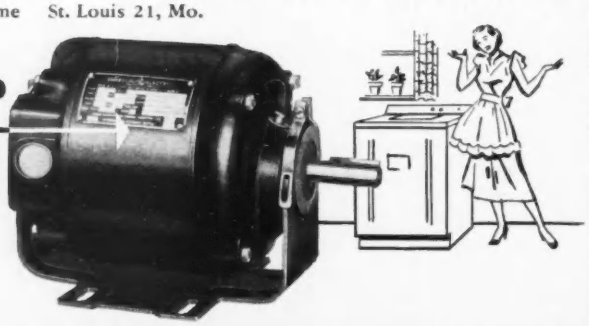

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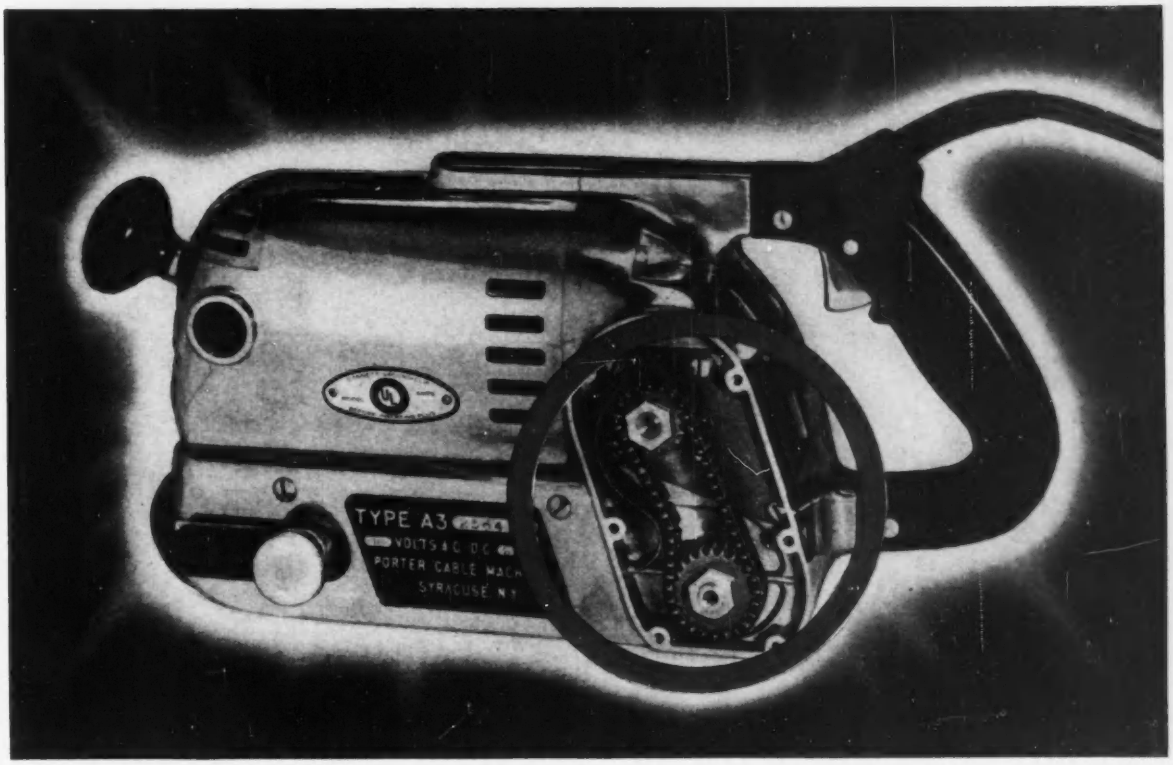
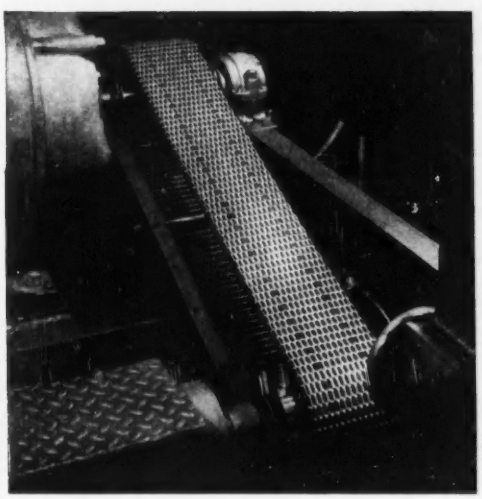


Portable belt sander is driven with Link-Belt 3/16-in. pitch silent chain. This compact, high-speed chain operates over small wheels, utilizes a spring shoe type tightening mechanism. Its exclusive link and tooth form eliminates chordal disturbance.



Printing "class" magazines calls for precise register of exacting color illustrations at high speeds. As on the majority of the country's high-production presses, Link-Belt Silent Chain provides the drive for this 5-color press that turns out 15,000 impressions per hour.

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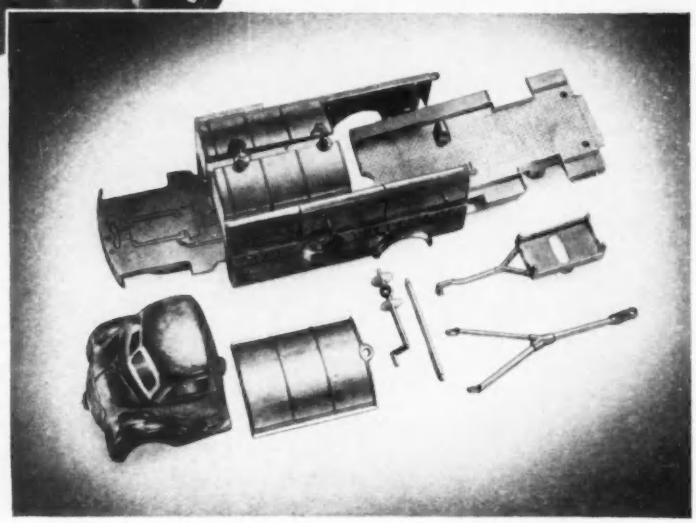


Faithful reproduction of detail is an easily obtainable characteristic of ZINC Die Castings, exemplified by toy and scale model applications. This foot-long Bell telephone truck—by Hubley—is almost wholly assembled with the pictured ZINC Die Castings. The reasons behind this selection of metal and method should be of interest to product engineers in fields far removed from the world of make-believe.

Because of the excellent castability of ZINC Die Casting Alloys, it is possible to produce parts which follow faithfully every infinitesimal detail machined into the die casting die. Furthermore, ZINC Alloys are cast in high speed plunger-type machines with long die life assured—thanks to the relatively low melting point of ZINC. Add to this the inherent strength and excellent finishability of ZINC Die Castings and you will appreciate why Hubley utilizes them for toy production—and why they are preferred in most other fields of product engineering.

In selecting a die casting alloy there are many factors —both physical and mechanical—to be considered in addition to the base price of the metal. Ask any commercial die caster about the advantages of ZINC over other die casting metals—or write to us.

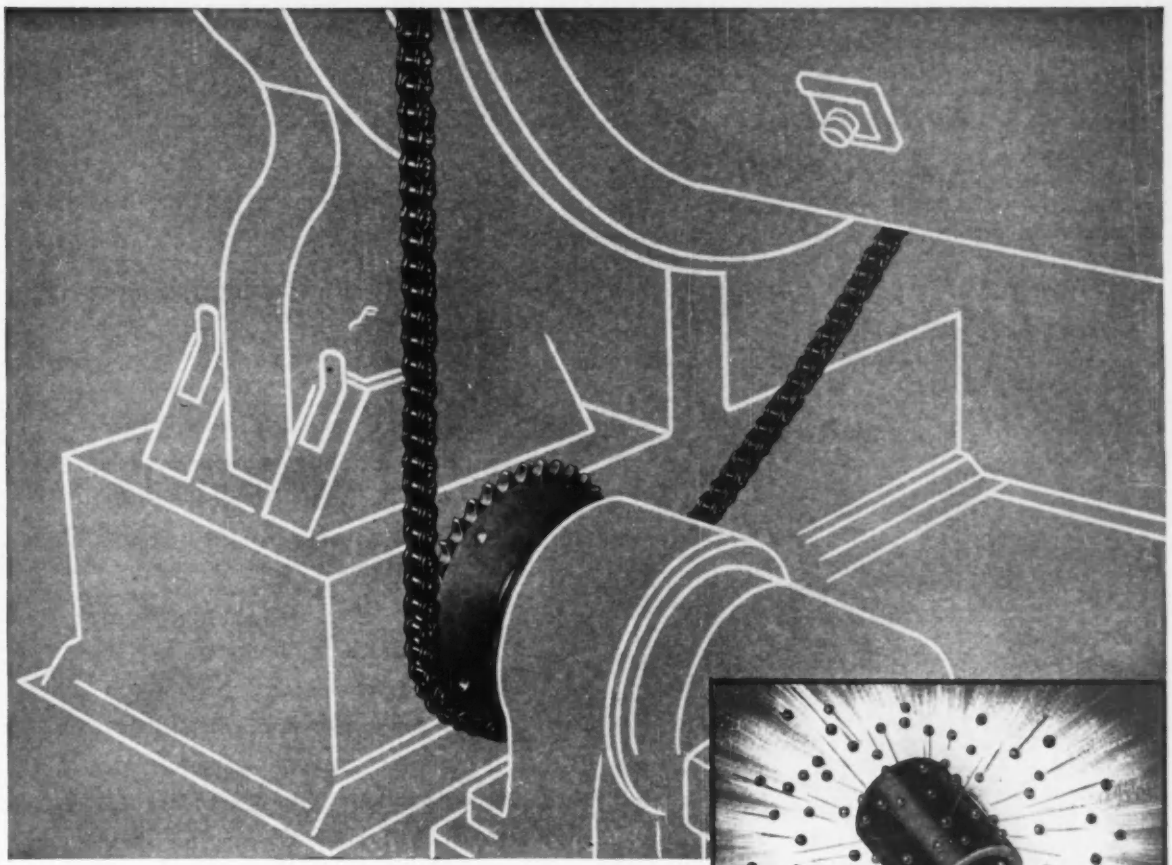
SEND FOR YOUR COPY

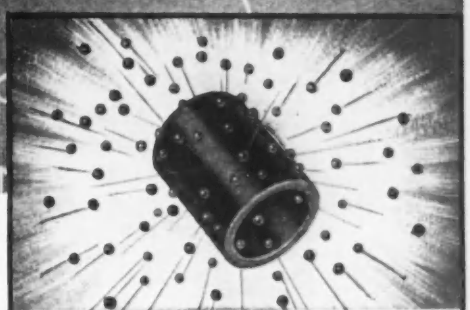
The New Jersey Zinc Company
160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

There's EXTRA LIFE built into LINK-BELT roller chain





Look for the distinguishing darkened rollers. Thousands of tiny steel balls hammer the metal—"cold work" each roller . . . pay off in extra fatigue life . . . added ability to withstand shock and impact of today's heavier loads.

Shot-peened rollers are just one of many engineering extras you get from LINK-BELT

WHETHER it's for drive or conveyor service, every Link-Belt Roller Chain gives you a performance bonus. In addition to shot-peened rollers, lock-type bushings multiply capacity to withstand shock loading. And closer heat-treat control, rigid testing and thorough inspection pay off in greater uniformity . . . extra years of life. Link-Belt Precision Steel Roller Chain is built in single or multiple widths, ⅜″ through 3″ pitch. Double pitch 1″ through 3″. A call to your nearby Link-Belt office will bring you prompt, expert service. Send for Engineering Data Book No. 2457.

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— in copper and copper base alloys, aluminum and electric welded steel for wide number of commercial applications.
CAPRAYOR*
— the capillary tube for restriction purposes — made of copper in sizes .026" to .080" I.D. In straight lengths only, 2½' to 21'.
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SPUN END PROCESS†
— an exclusive Wolverine development designed to form ends of tube (completely or partially closed) to affect economies in tubular parts.

it takes "Tube-manship" to make good tube

By "tube-manship" we mean the combination of research and engineering, with long tube-making experience to produce the quality of tube that will meet all requirements which its application demands.

A tube possesses "tube-manship" (1) when all its dimensions conform consistently to highest standards, (2) when it is made of dependable metals and alloys according to best practices, (3) when it has passed rigid inspection during all steps of production.

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Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

*REG. U.S. PAT. OFF.
†A PATENTED PROCESS RE. 22465

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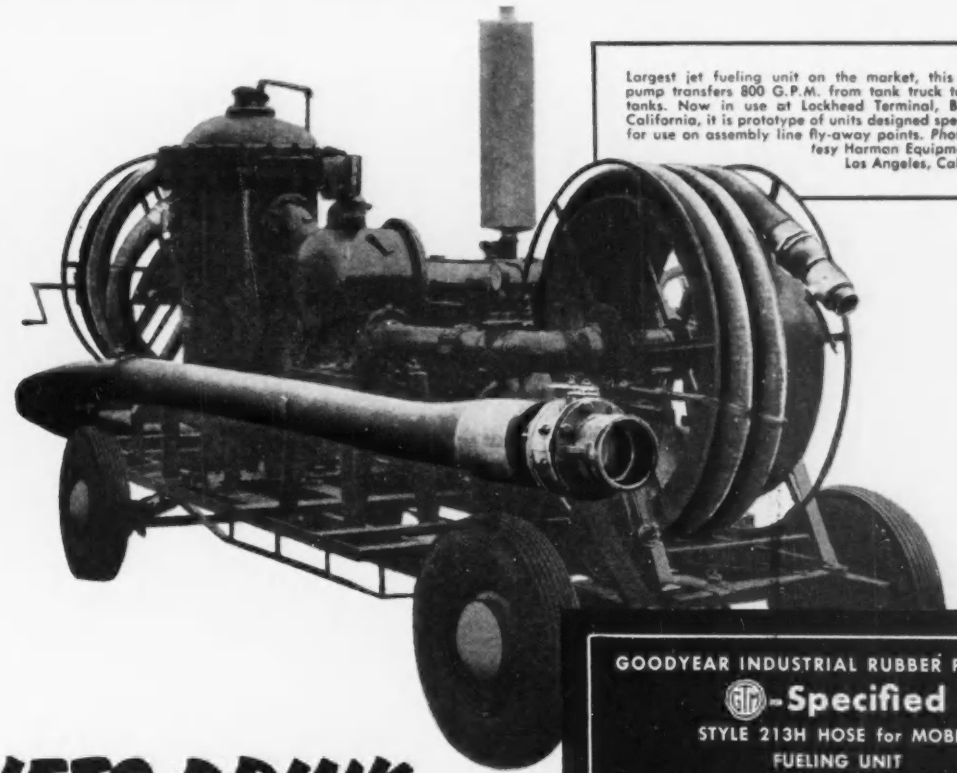


Largest jet fueling unit on the market, this mobile pump transfers 800 G.P.M. from tank truck to plane tanks. Now in use at Lockheed Terminal, Burbank, California, it is prototype of units designed specifically for use on assembly line fly-away points. *Photo courtesy Harman Equipment Co., Los Angeles, California.*

JETS DRINK 800 G.P.M.

through this G.T.M.-Specified Hose

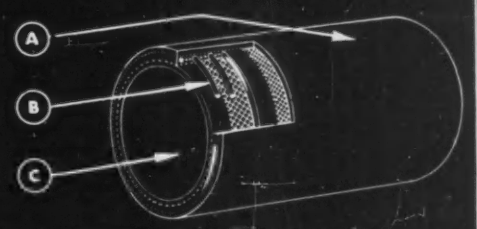
THE manufacturer of this jet fuel pumping unit called in the G.T.M.—Goodyear Technical Man—to specify the hose constructions required to insure its 800 G.P.M. flow from tank truck to aircraft. The G.T.M. studied the unit—then recommended Goodyear Style 213H Suction Hose for the intake side of the unit, WWH Tank Truck Hose for the four discharge hoses.

The manufacturer was sold on these recommendations—both for long, trouble-free service and for hose flexibility and ease of handling. Choosing the *right* hose for your product from the more than 800 types of hose made by Goodyear calls for expert assistance, too—the kind you get by calling in the

GOODYEAR INDUSTRIAL RUBBER PRODUCTS

GTM-Specified

STYLE 213H HOSE for MOBILE FUELING UNIT



A — Abrasion-, oil-, gasoline-, sun- and weather-resistant cover

B — Reinforcement plies of close-woven fabric encasing helix of round steel wire

C — Tube resists gasoline and oils

G.T.M.—the man who knows hose best. So see him today with your specific design problems, or write Goodyear, Mechanical Goods Div., Akron 16, Ohio.

YOUR GOODYEAR DISTRIBUTOR *can quickly supply you with Hose, Flat Belts, V-Belts, Packing, Tank Lining, Rubber-Covered Rolls. Look for him in your Telephone Directory under "Rubber Products" or "Rubber Goods."*

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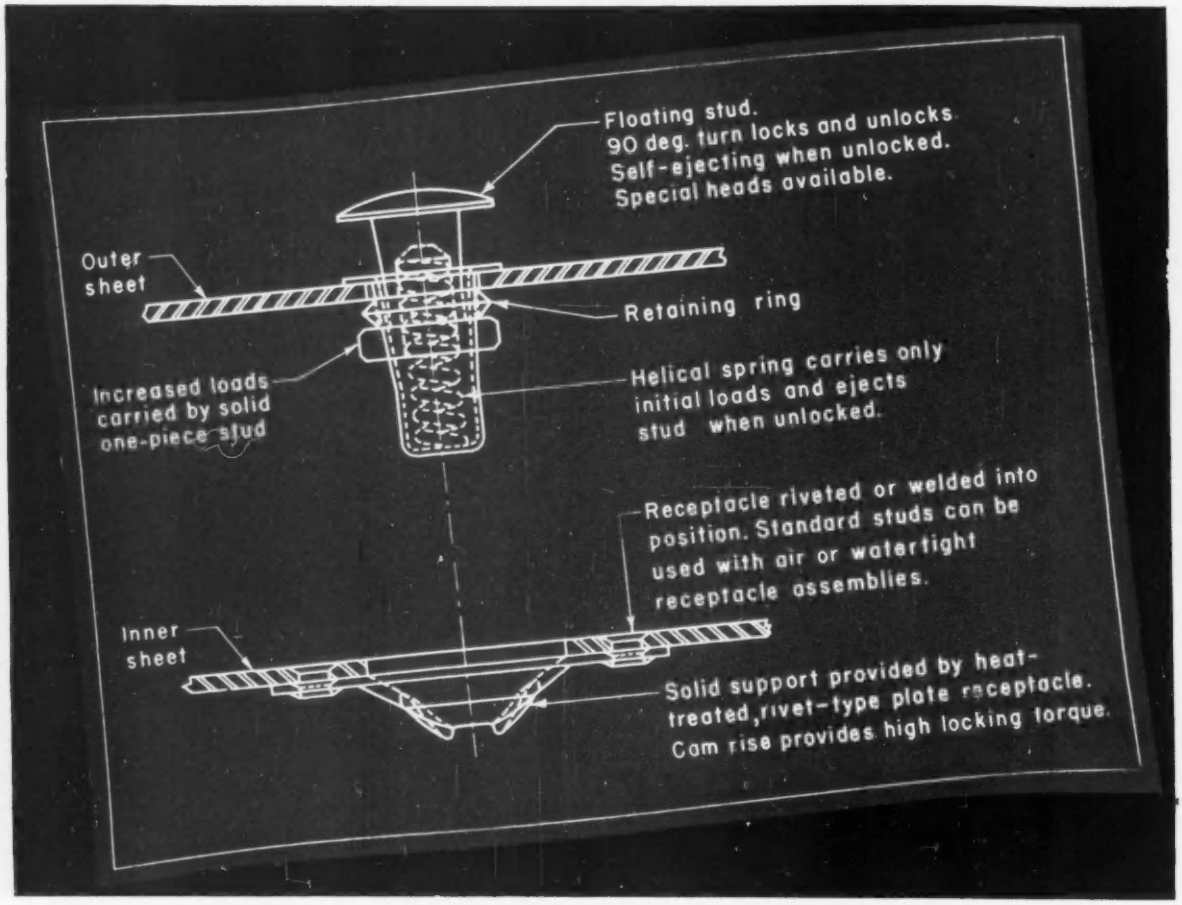
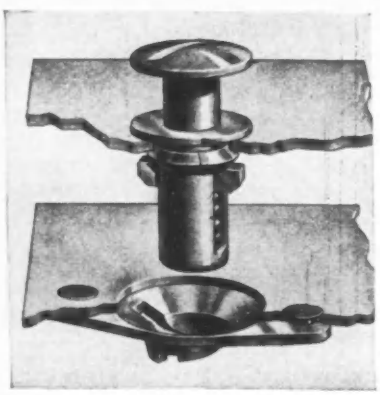

Floating stud.
90 deg. turn locks and unlocks
Self-ejecting when unlocked.
Special heads available.
Outer sheet
Retaining ring
Increased loads carried by solid one-piece stud
Helical spring carries only initial loads and ejects stud when unlocked.
Receptacle riveted or welded into position. Standard studs can be used with air or watertight receptacle assemblies.
Inner sheet
Solid support provided by heat-treated, rivet-type plate receptacle. Cam rise provides high locking torque.

HOW QUICK-LOCK CUTS FASTENING COSTS



A glance at the drawing shows the advantages of QUICK-LOCK's efficient design. QUICK-LOCK speeds up the mounting and demounting of detachable panels, works equally well on curved or straight sheets.

QUICK-LOCK is adaptable to many different fastening applications in the aircraft, automotive, railroad, electrical and appliance fields. Let Simmons engineers help you cut assembly costs. Write for literature and samples today.

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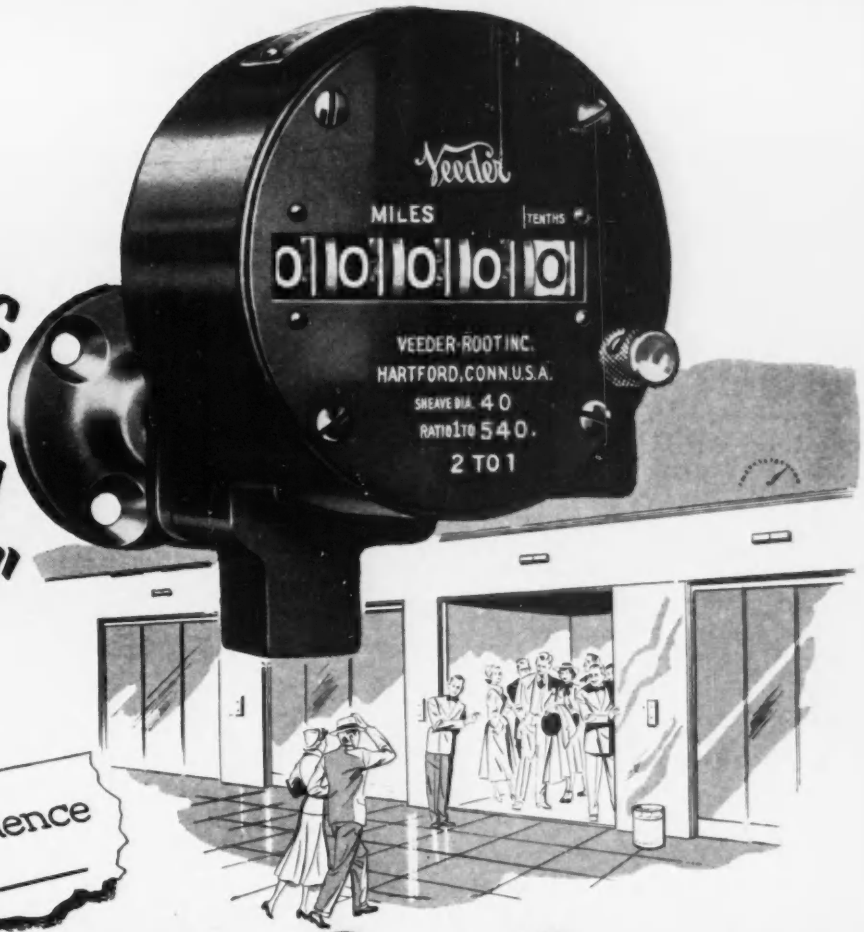
FASTENERS THAT IMPROVE PRODUCTS AND REDUCE ASSEMBLY COSTS



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Warner Electric Clutches permit automatic settings within "tenths" on Giddings & Lewis Horizontal Bar

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- **gives positive, no-slip engagement required for close accuracy**
- **releases completely, instantly with simple limit switch control**
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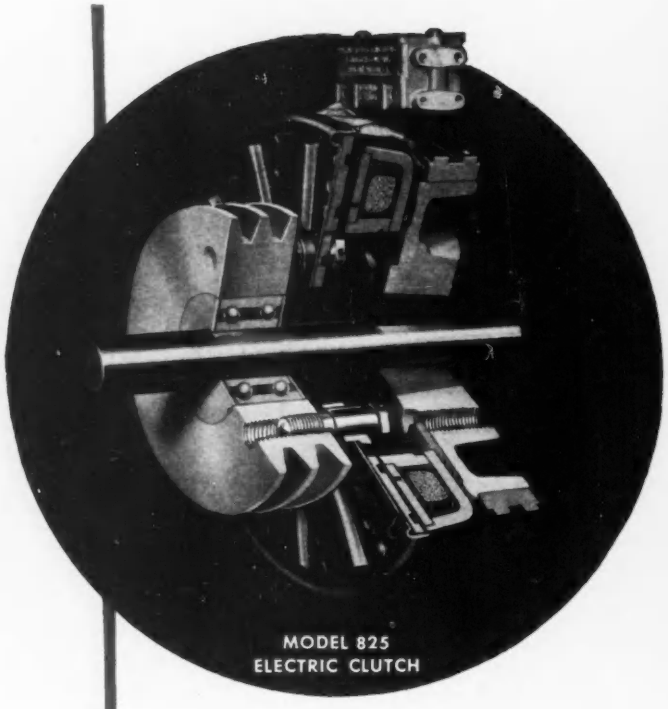

MODEL 825
ELECTRIC CLUTCH

Here's how advanced engineering can find easy solutions to complex machine set-up problems. Automatic control of table and headstock movements on G & L's Horizontal Bar locates a series of holes in workpiece within .0002" to .0005". Device consists primarily of a master switch for table and headstock, motor-driven reduction gear box for each unit and two Warner Electric Clutches. Here's how it works.

Operator makes predetermined settings with measuring rods and micrometer. When "start" button is pressed, positioning device automatically controls vertical headstock and lateral table movements, accurately positions and repositions workpiece for each boring operation.

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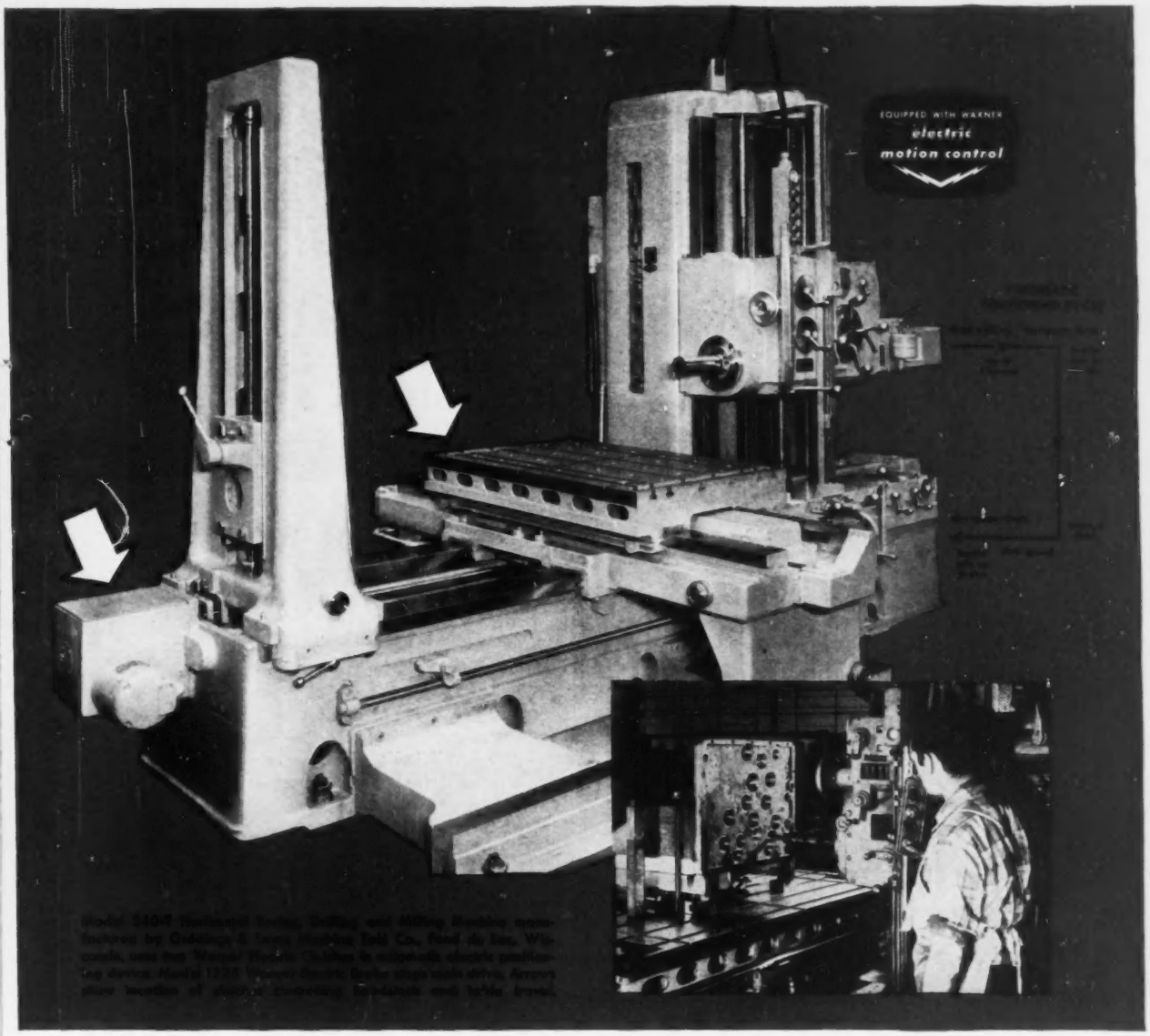
WARNER

ELECTRIC BRAKES & CLUTCHES

FOR INDUSTRIAL APPLICATION



Warner Electric Brakes, Clutches and Clutch-Brakes give you new, unique simplicity of design and operation. There are only two main parts, an armature and magnet. Operation is by *electro-magnetic*, instantaneous engagement and release of friction surfaces. Torque ratings are extremely high for their small size and light weight. No coasting or slipping when "locked in." Easily designed into original equipment. Readily adapted to automatic cycles and remote control by limit switches, relays, electric eyes, pushbuttons, etc. Rate of application is accurately controlled to synchronize motions—give exact degree of speed and power required for your machine operation.

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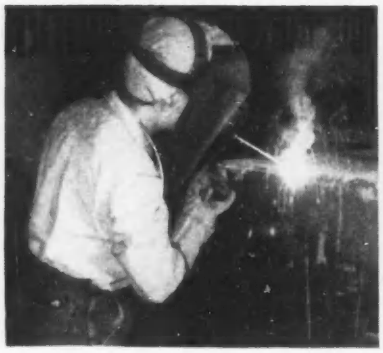
Look at the photos on these pages. Note the variety of Reynolds welding and brazing operations. Reynolds offers welding equipment ranging from 30 to 800 amp., like the automatic fusion welding equipment shown at right capable of continuous welding up to 63 inches per minute and featuring built-in crater fillers that permit crater-free welding. Remember, too, Reynolds constant quality control minimizes "down time"—cuts your costs.

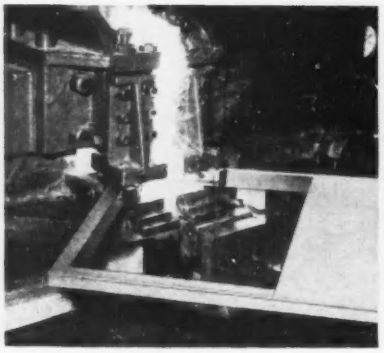
For full details on these operations and on the many other services offered by Reynolds Aluminum Fabricating Service, call your Reynolds office listed under "Aluminum" in your classified telephone directory or write Reynolds Aluminum Fabricating Service, 2051 So. Ninth St., Louisville 1, Kentucky.

Write for your copy of the new 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.

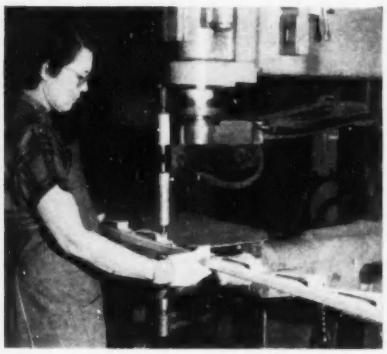
SEE "Mister Peepers" Sundays, NBC-TV. HEAR "Fibber McGee and Molly" Tuesdays, NBC radio. Consult local listings for time and station.



Flux coated metal-arc welding in a Reynolds plant.



Reynolds plant photo showing flash welding of aluminum.



Spot welding clips to roll formed patio awning beam in a Reynolds plant.

REYNOLDS ALUMINUM

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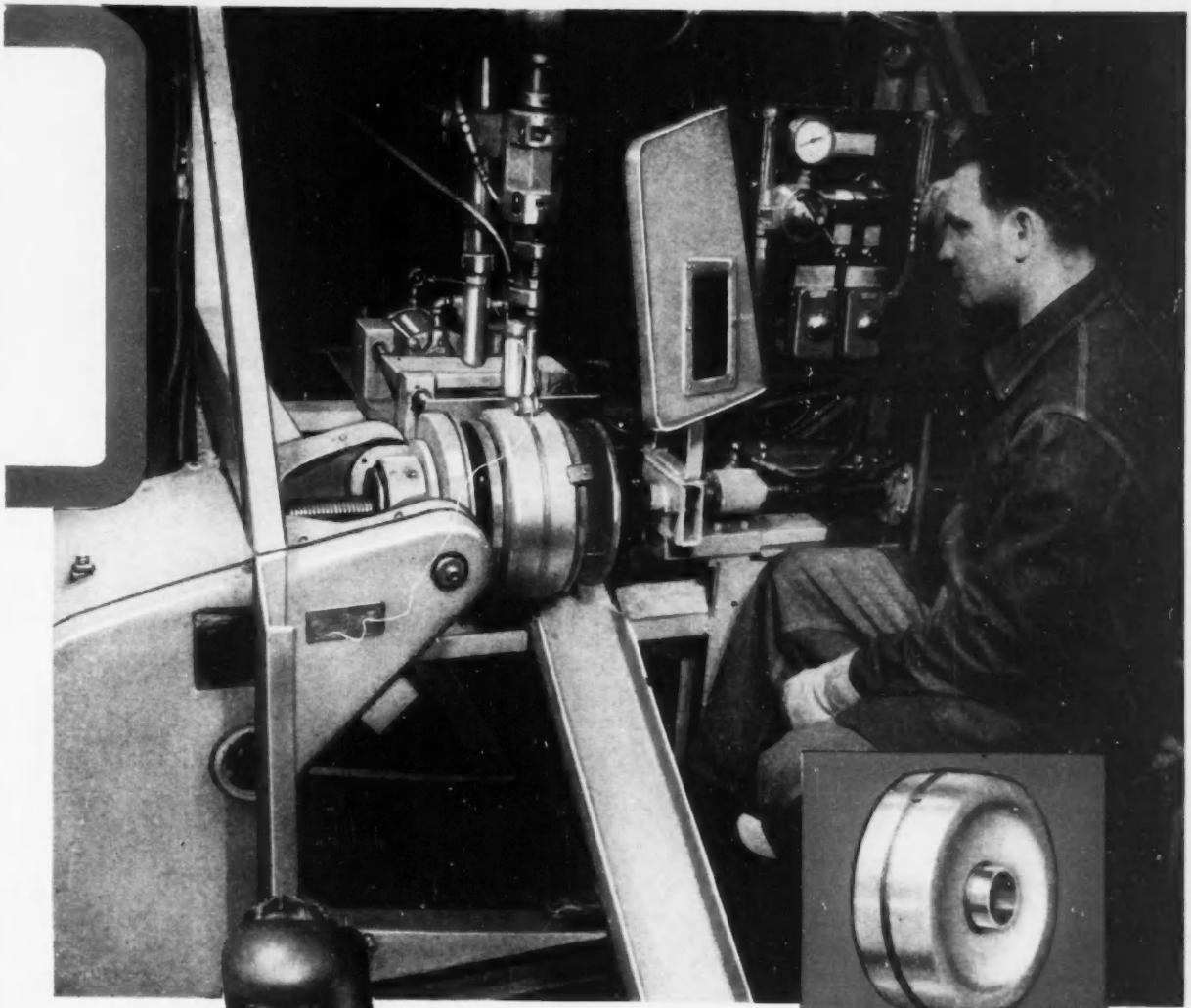

Reynolds automatic fusion welding equipment. Small photo shows finished trailer wheel welded on this equipment in a Reynolds plant.

Inert-gas-shielded arc welding on aluminum tubing in a Reynolds plant.

A conveyorized brazing furnace in a Reynolds plant.

FABRICATING SERVICE

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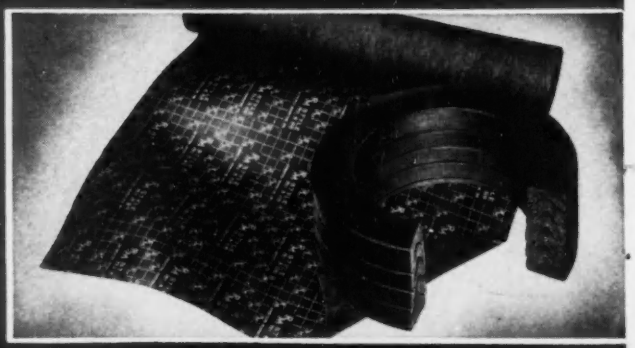
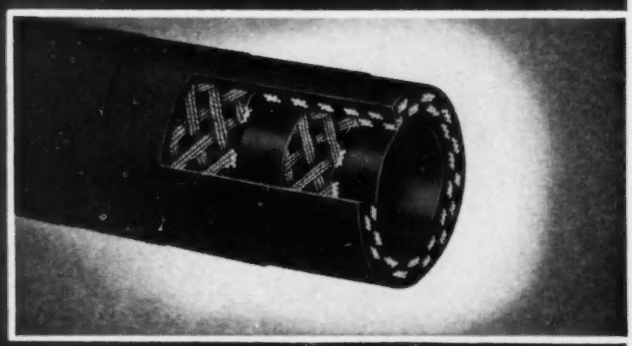
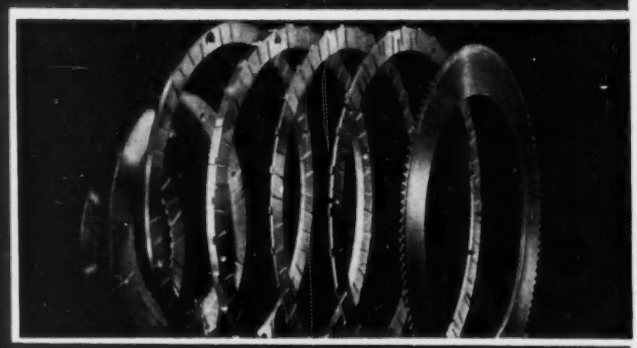


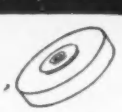




Brake Blocks, Linings and Clutch Facings

Fan Belts and Radiator Hose

Mechanical Packings and Gaskets



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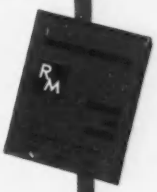
Raybestos-Manhattan makes a wide variety of packings and gasket sheets, and an unusual number of asbestos textiles. Illustrated are two packings typical of the diversity of the R/M Packing line. K-68® is a compressed asbestos sheet with Neoprene binder. It has outstanding resistance to solvents of the gasoline and aromatic types. Vee-Flex® Packing Rings are uniquely designed to provide automatic sealing. R/M also stands ready to meet your specifications for Teflon packings, rods, sheets, tubes, tape and fabricated parts.

**Du Pont trade-mark for its tetrafluoroethylene resin*



PACKINGS, GASKETS, ASBESTOS TEXTILES AND TEFLON PRODUCTS

Packing Division or
Asbestos Textile Division
Raybestos-Manhattan, Inc.
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Manheim 5-2211

MECHANICAL RUBBER PRODUCTS

If your design project calls for hose, chances are R/M engineers have *already* designed just the hose you need. Special types for acid, oil, sandblast, paint spray, chemicals—types for easy flexing like Homoflex for air, water and other general use. Homoflex is typical of R/M engineering—it's strong, yet light and "flexible as a rope," with no preset twist. Cover and tube are inseparably joined through the specially designed strength member. If none of these fit your requirements R/M will make a hose that does! Of course, R/M also can help solve your problems on transmission and conveyor belts, V-belts and molded rubber products. Let R/M work with you.

MECHANICAL RUBBER PRODUCTS

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Raybestos-Manhattan, Inc.
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Raybestos-Manhattan makes a variety of sintered metal products like those shown. These "Stop-and-Go" products of powdered metal are increasingly important in the automotive, aviation and earth-moving industries, especially where operations involve extreme temperatures. They are typical of the many different clutch and brake parts made by R/M. Whether of metal, or of woven or molded asbestos, every R/M friction element is engineered to meet your specific operating conditions.

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R/M

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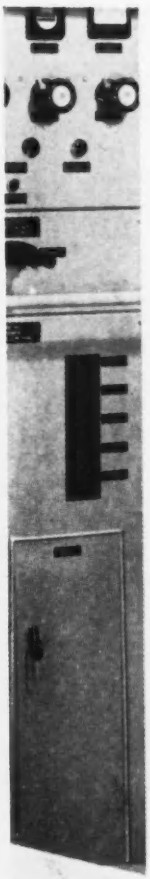
Top—"G" Type Undervoltage Trip
"F" Type Breaker
"J" Type Breaker

Bottom—"E" Type Breaker
550 Volts, D-C; "G" Type Blowout Arc Chute
"G" Type Auxiliary Switch
"J" or "K" Type Shunt Trip

ways Westinghouse AB Circuit Breakers can do more for you



. . . to give you greater flexibility for panel, switchboard or control cabinet requirements

Westinghouse can help you build better equipment for bigger sales. How? By providing new, low-cost ways of offering your customers greater circuit capacity in less space, special breakers for tough applications, and modifications and accessories for unusual operating conditions.

1. New Quicklag® Plug-in Thermal-Magnetic De-ion® Breaker—saves 25% mounting space; plug-in contacts speed assembly.
2. New E Breaker—with capacity increased from 50 to 100 amps without increasing frame size; provides the capacity but saves the price of heavy-duty panelboards.
3. New J Breaker—only 10⅛″ high as compared with the 15½″ height of conventional 225-amp breakers; saves up to 34% mounting space.
4. New Visible Blade De-ion Switch Line—30, 60, 100, 200-amp ratings—smaller, but with higher interrupting capacities than other devices of comparable ratings.
5. P-1 Circuit Breaker—high vibration and impact resistance; for PCC and railroad cars, locomotives, rapid transits, trolley coaches.
6. New Ground Current Limiter—stops dangerous current leakages at from 3 to 20 amps independently of breaker trip elements—for greater safety in mines and damp locations.
7. Undervoltage Protection—trips breakers automatically when line voltage drops to approximately 50% or less than normal.
8. Shunt Trip—trips breaker instantly from remote point; has solenoid-plunger combination with cutoff switch to break actuating current after operation.
9. Remote Control—provided by motor operator on K and L Breakers.
10. Breakers for Unusual Conditions—specially selected and treated parts are used in breakers for extremely moist or corrosive atmosphere, or where fungus growths are prevalent.

These developments in safer, more complete circuit protection pin point many modern design, function and assembly problems. But they are only a few of literally scores of circuit devices available to you.

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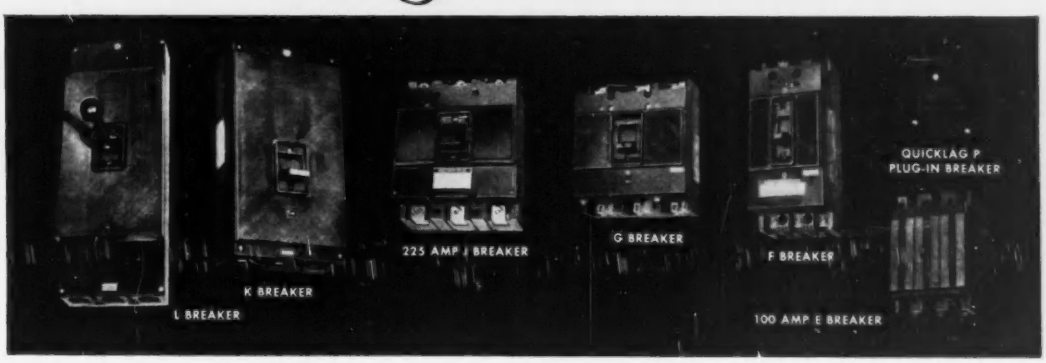
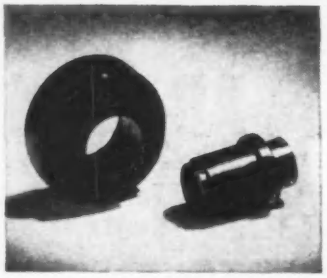
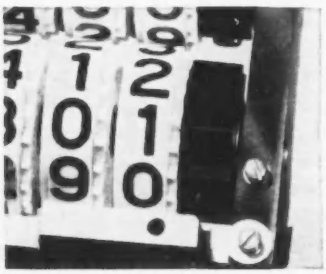


54 parts in this

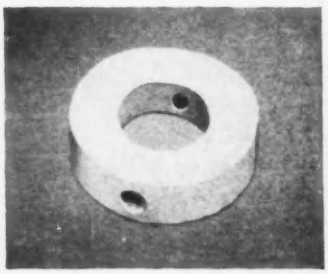
NYLON STARWHEEL is molded in one piece . . . *simplifies design* . . . saves manufacturing steps.



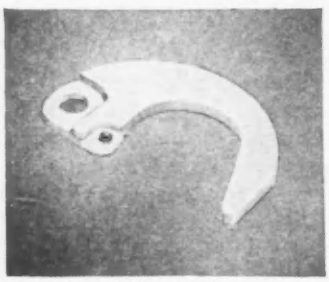
NYLON ASSEMBLY has *excellent bearing characteristics* . . . low coefficient of friction.



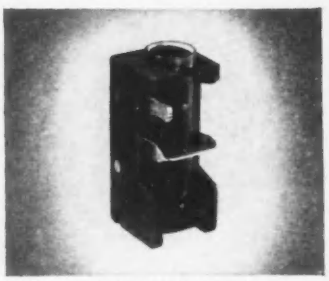
NYLON RATCHETS that control counter wheels are *lightweight*. . . combat inertia . . . guarantee accurate operation.



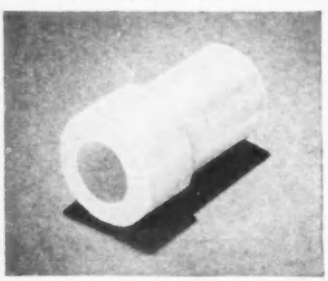
NYLON WHEEL is *strong, tough, dimensionally stable* . . . may be dyed for assembly identification.



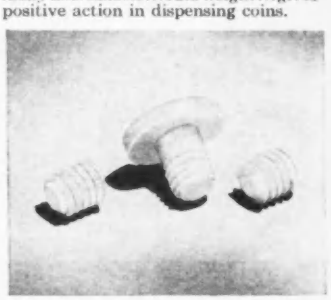
NYLON SHAFT LOCK is *molded to close tolerances* . . . finishing operations are minimized or eliminated.



NYLON CHANGE CARRIER is *virtually unbreakable* . . . cuts weight . . . gives positive action in dispensing coins.

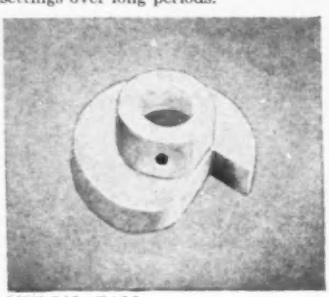


NYLON BEARINGS *need no lubrication* after installation . . . operate quietly . . . give long, dependable service.

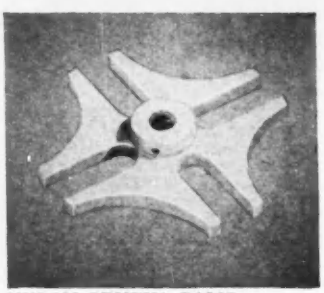


NYLON SCREWS are *resilient* . . . have "self-locking" properties . . . hold settings over long periods.

NYLON KNOBS are *smooth, tough* . . . pleasant to the touch . . . keep their newly finished appearance.



NYLON CAM *resists wear* . . . is strong, will not chip or crack . . . needs no lubrication.



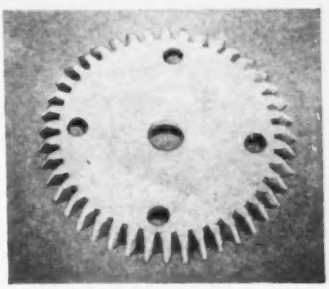
NYLON GENEVA CAMS are *strong in thin sections* . . . *unaffected by corrosion* . . . cut manufacturing costs.

# of Du Pont nylon plastic new fare collector

The Grant Electrofarer is a completely automatic fare-collection device . . . gives drivers an audible count and visible check of coin deposits. It can receive a single- or multiple-coin fare deposited in any combination of up to five coins and tokens, record the amount, then separate and drop each coin into its change carrier. It eliminates all driver fare handling except making change . . . contributes to safer, faster service.

The device incorporates 54 different parts of Du Pont nylon plastic. These parts (a few are illustrated) show how the engineering properties of Du Pont nylon can contribute to better product performance, often at less cost.

The parts were molded from Du Pont nylon by The Danielson Mfg. Co., Danielson, Conn., for Grant Money Meters Co., Providence, R. I.



NYLON GEARS can *operate continuously to 250°F.* . . . are readily molded in one operation . . . cut costs.

Du Pont nylon parts can be economically mass-produced by injection molding . . . are light in weight . . . give better performance. Nylon molding powders are available in a number of compositions, each with different properties, for mechanical, electrical and other uses. For information, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room 106 Du Pont Bldg., Wilmington, Delaware.

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BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

Why pay for unneeded precision in ball bearings?

In many applications where speeds and loads are moderate, you don't need a precision bearing. When this is the case, Schatz "Commercial" Ball Bearings can cut your costs by as much as 85%—*without any sacrifice in operating efficiency!*

Why are savings like this possible? Because "Commercial" Ball Bearings are designed to wider tolerances than precision bearings...because they are available unground, partially-ground, or fully-ground. And, because, in almost all cases, cages are not used.

If you have an application where speeds and loads are moderate, it will pay you to look into Schatz "Commercial" Ball Bearings. To learn how you may save, write for literature described below.

THE SCHATZ MANUFACTURING COMPANY
6753 Fairview Avenue, Poughkeepsie, New York

Schatz "Commercial" Bearings used on these products

Dishwashers • Outboard motors
Automobile steering mechanisms
Elevators • Box machinery
Office equipment
Flexible shafts • Lawn mowers
Masonry cutting equipment
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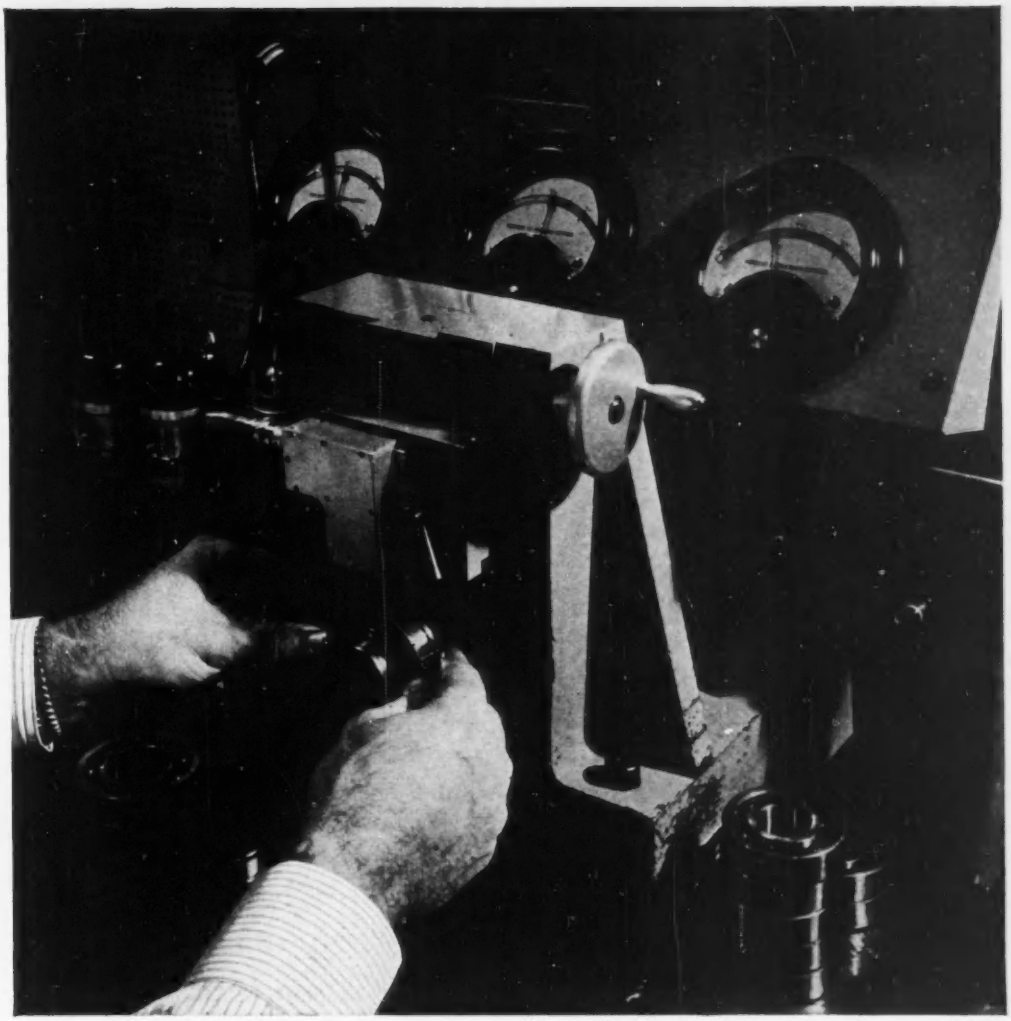
What about *your* product?

The oldest, largest manufacturer of "Commercial" ball bearings

SCHATZ
"Commercial"
BALL BEARINGS

Technical literature available:
Schatz Catalog 11 contains drawings and specifications of Schatz Ball Bearings.
Technical Bulletin tells how to determine proper type and size "Commercial" Ball Bearing for various speeds and loads.
Nylon Bearing Parts discusses advantages of nylon parts in "Commercial" bearings.



He listens by looking...

And why not? It takes the guesswork out of test work.

QUIET BALL BEARINGS are longer running, smoother running, and stand up better under heavy loads.

That's why Federal inspectors rely on their eyes rather than their ears when testing the sound of a bearing. They use an Anderometer, a highly sensitive machine which picks up a bearing's slightest whisper and translates it into electrical impulses. By glancing at the dial indications, the inspector can easily tell if the bearing measures up to Federal standards.

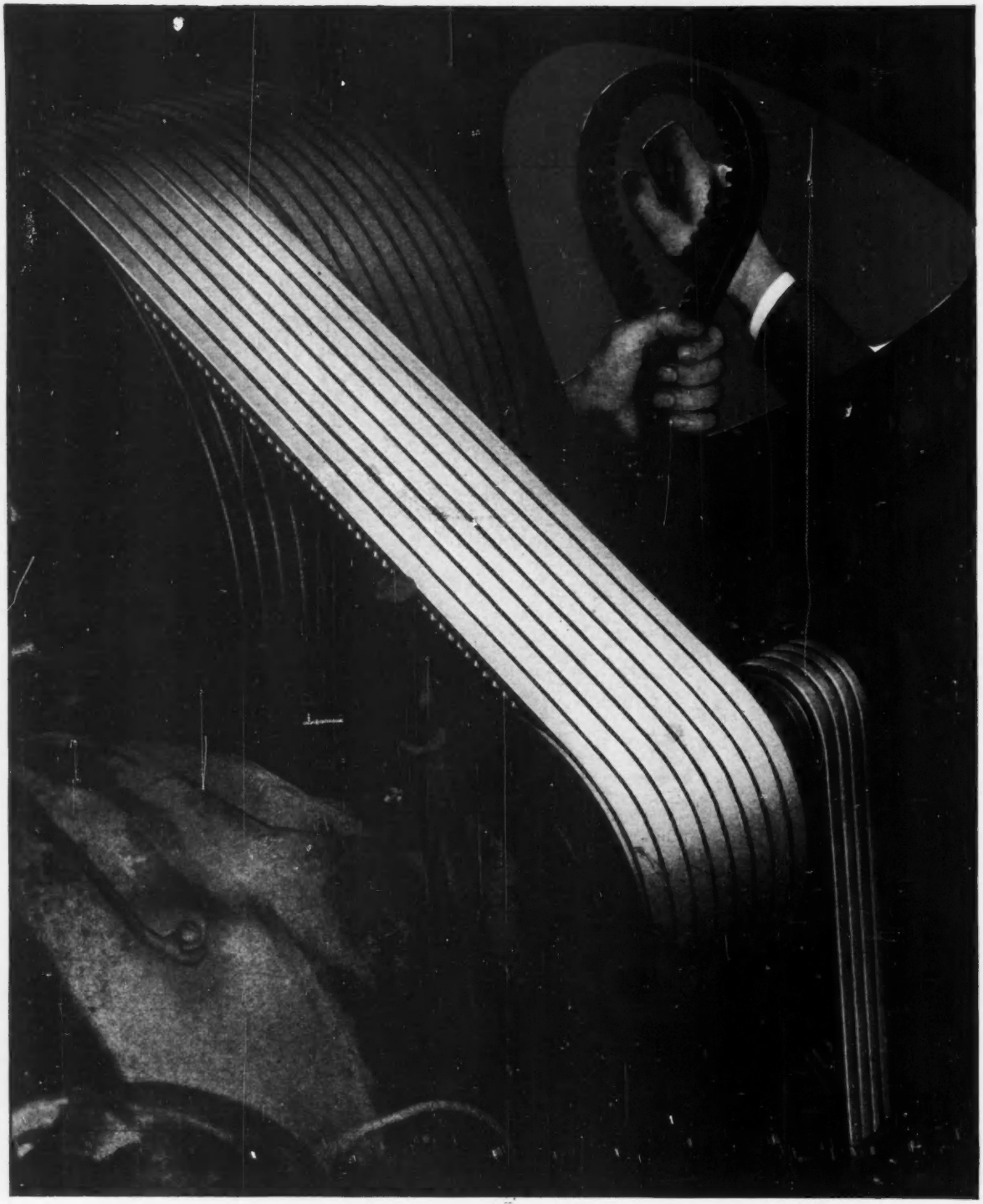
This "listening by looking" is but one of the many tests that guarantee top-notch performance from *every* Federal Ball Bearing.

The Federal Bearings Co., Inc., Poughkeepsie, N. Y.

Federal

Ball Bearings

One of America's Leading Ball Bearing Manufacturers



Here's a typical example of how the extra power capacity of Cog-Belts can solve design problems. Two diesel engines drive the pump on this sand and gravel dredge, and the former 16-belt drive handled a constant 140 horsepower load. When it was planned to step this up to 188 horsepower, 16 belts weren't enough. But adding more belts meant adding more grooves to the pulleys—and there was *no room* for large pulleys! The engineers were faced with redesigning the entire dredge, in order to make use of the engines' new output. Then 16 *Cog-Belts* were put on the drive. The same pulleys were used, but the Cog-Belts easily carried the 48 horsepower load increase. Instead of a complete redesign job on the dredge, it was a simple matter of changing from conventional V-Belts to Cog-Belts!

Want to save weight, space and cost on your V-Belt drive design?

This may be your answer . . . Cramped for drive space in your new design? If up to 25% shorter center distances will solve your problem, investigate the Dayton Cog-Belt.* It has no difficulty in operating on much shorter center distances than conventional V-Belts require.

If *weight* is your design problem, the Cog-Belt can lighten your design by as much as 28%. How? Because you can specify smaller pulleys . . . shorter belts . . . and, frequently, *fewer* belts.

Is *cost* the biggest headache in your design? Then be sure to see what the Cog-Belt offers the design engineer. In a great many instances, the greater horsepower rating of the Cog-Belt permits using *fewer belts, and pulleys with fewer belt grooves.* The savings possible in such cases are obvious. Even in drives which require the same number of belts, the pulleys for the Cog-Belts may be smaller (and thus cheaper) and the shorter center distances lend cost-cutting compactness to your design.

Send for design data!

Get the complete engineering story on how Dayton Cog-Belts save cost, weight, and space. Send for Dayton's 384-page design guide. And, of course, feel free to call on Dayton's engineering staff for help with your drives. No obligation — just write, wire, or phone.

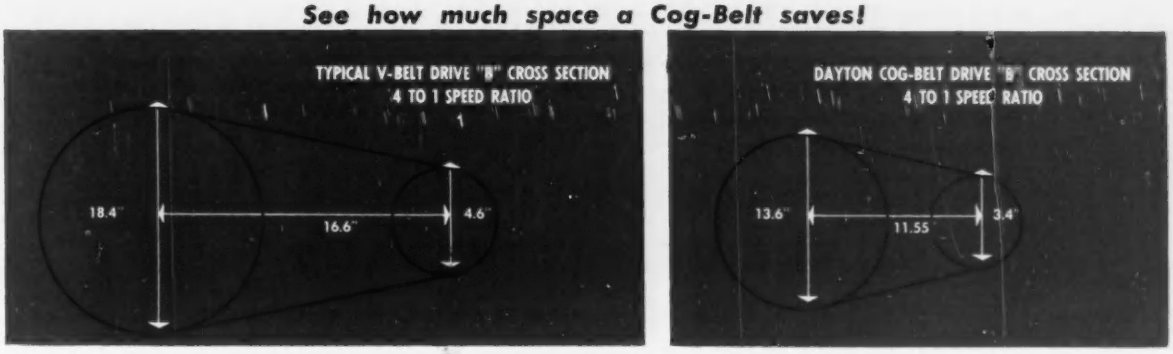
*T.M.

Dayton Rubber

Since 1905

WORLD'S LARGEST MANUFACTURER OF V-BELTS
DAYTON 1, OHIO

See how much space a Cog-Belt saves!



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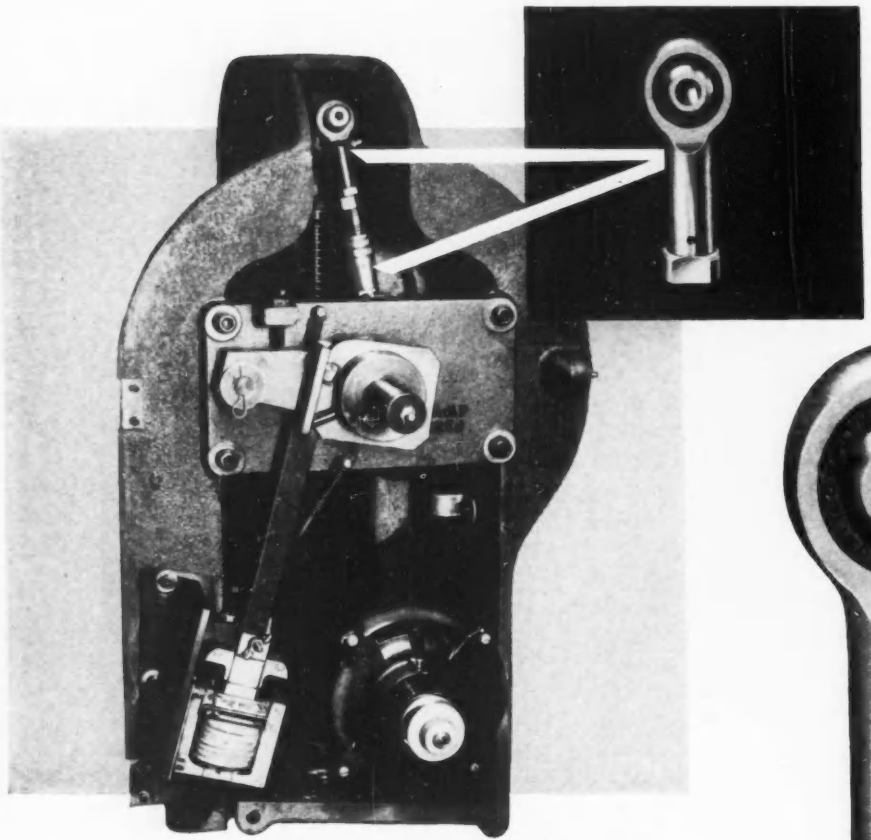
The Cog-Belt means a 30.6% saving in center distance . . . a 26% saving in height . . . a 47.2% saving in drive area!

HEIM Unibal Spherical Bearing Rod Ends

HELP TO STREAMLINE DESIGN!



Two Heim Unibal Rod Ends are used to form the link between the crankshaft and the toggle lever on this Amp-O-Lectric Automatic Wire Terminator made by Aircraft-Marine Products, Inc., Harrisburg, Pa. This application of Heim Unibal Rod Ends made it possible to eliminate the exposed crank and ram, streamlined the machine, and permitted turning the crankshaft and flywheel 90°, so that flywheel could be located at rear of machine, and allowed the heavy flywheel and motor to be lowered considerably.

Incorporate Heim Rod Ends in your machine for smoother, improved operation and design. Write for catalog of Unibal Bearings and Rod Ends.

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Drives for Designers
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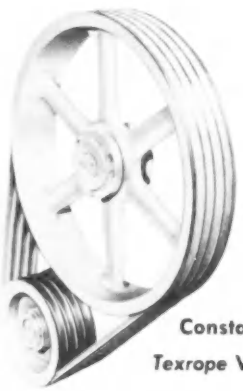
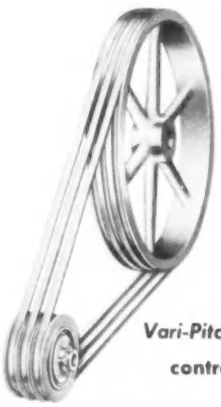
Everything from Power Line to Driven Shaft
Control
Motor
Texrope V-belt Drive
A-4006

Designed to

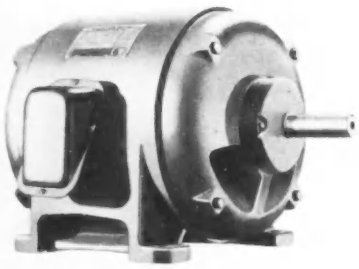


Constant speed
Texrope V-belt drive



Vari-Pitch stationary
control drive

Vari-Pitch motion
control drive



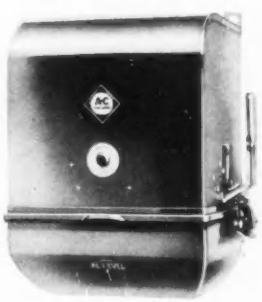
Open, drip-proof
squirrel cage motor

Totally-enclosed, fan-cooled
squirrel cage motor

Open, drip-proof, face-mounted
vertical squirrel cage motor

Across-the-line manual starter

Combination
starter



Reduced voltage starter

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Work Together

Texrope Drives

Texrope V-belt drives, the original multiple V-belt drive, are available in a complete range of sizes and types, both fixed and variable speed. More and more designers are finding that the moderate cost of *Vari-Pitch* sheaves is returned many times in increased machine versatility and more precise quality control. With either Stationary Control or Motion Control *Vari-Pitch* sheaves, speeds can be accurately adjusted quickly and easily over a wide range.

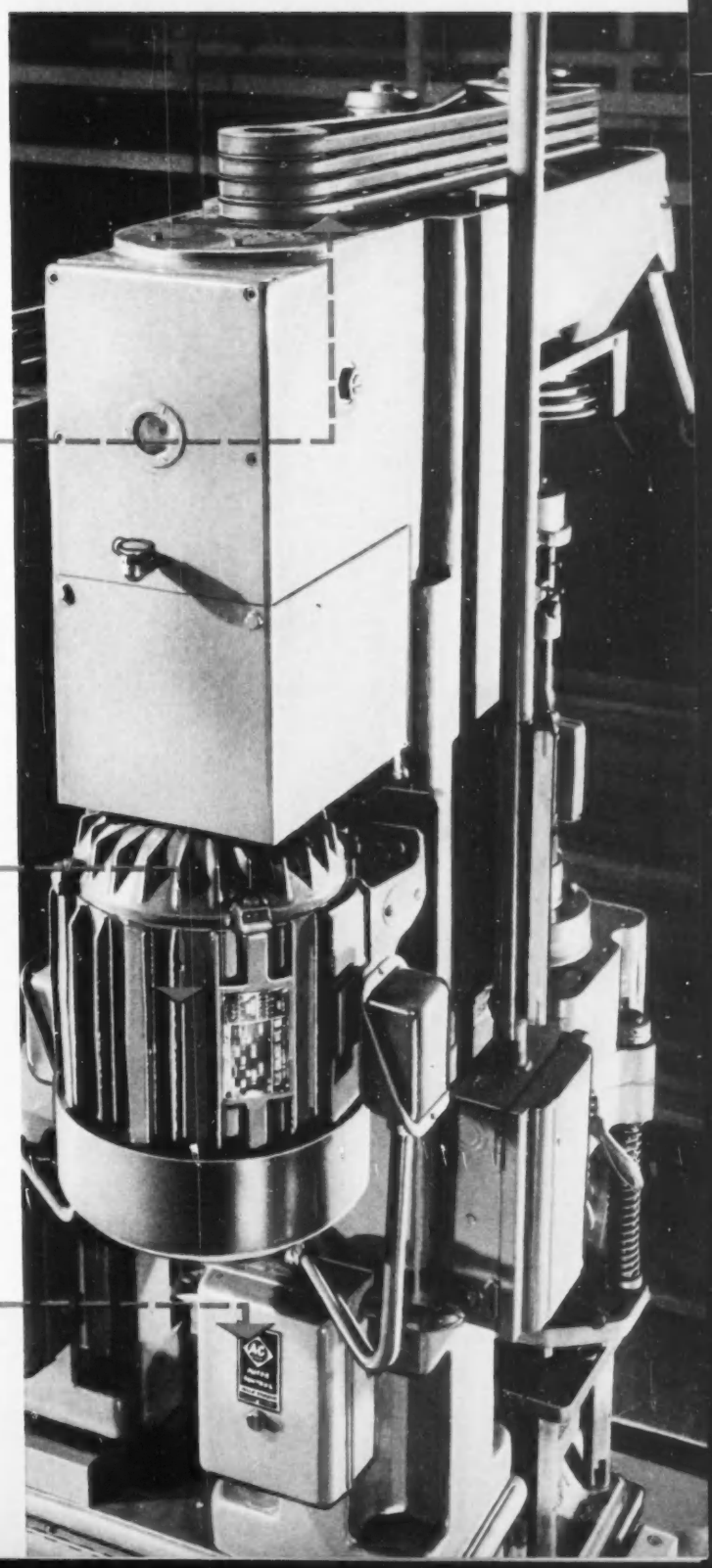
Texrope and Vari-Pitch are Allis-Chalmers trademarks.

Motors

Allis-Chalmers general purpose, special purpose and special design motors meet almost every designer's needs for motors from ½ hp up. Types include squirrel cage, wound rotor and dc for single or multi-speed operation. Available with a full range of torque characteristics and a wide option of enclosures and mounting methods. Special designs to meet any requirement. Shown at the right is a drilling machine equipped with a totally-enclosed, fan-cooled Allis-Chalmers motor. Reduced maintenance of the dirt-excluding fin-type design is making it very popular for machine tool applications.

Motor Control

Allis-Chalmers motor control is available for most designers' applications from size 0 up. Allis-Chalmers builds many types of squirrel cage and wound rotor motor control, dc motor control, and variable speed control for many applications. Shown here is a full voltage across-the-line starter with reset button.



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YOUR CUSTOMERS will have no trouble getting competent service on your products when you use Allis-Chalmers motors, control and drives. There are nearly 100 Allis-Chalmers Certified Service Shops located in every industrial area in the country.

Allis-Chalmers Certified Service Shops are hand-picked independent units which have been chosen for their modern equipment, efficient methods, wide experience and business integrity. These Certified Service Shops assure your customers of factory-approved parts and service methods on Allis-Chalmers drive equipment. If you use special motors, the factory makes available to all Certified Service Shops the necessary information to assure a good service job.

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Please send me the literature for designers checked below.

Motors

- ☐ Handy Guide to Motor Selection 51B6052
- ☐ Squirrel Cage Motors 51B6210

Control

- ☐ Handy Guide to Starters 14B7733
- ☐ Reduced-voltage Starters 14B7215

***Texrope* Drives**

- ☐ Handy Guide to *Texrope* Drives 20B6051
- ☐ *Vari-Pitch* Drive Engineering Data 20B7499

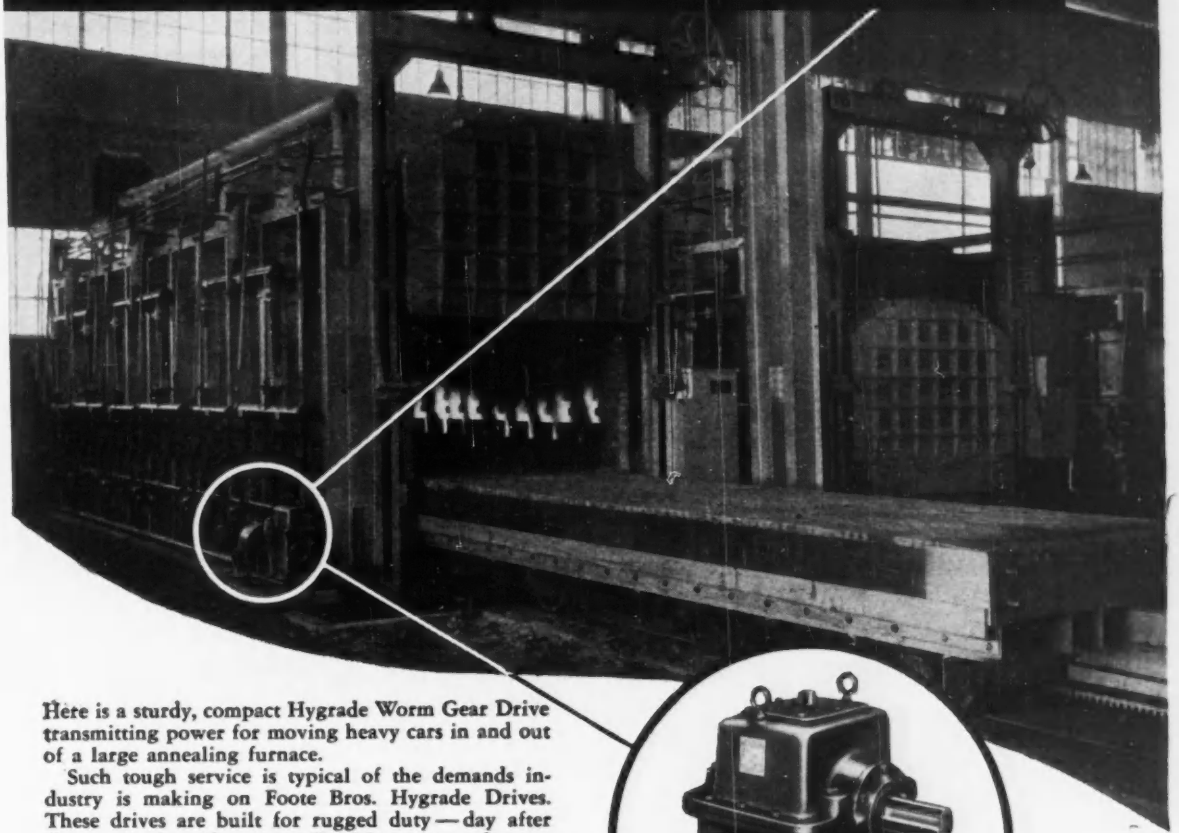
Name..... Title..... Company.....

Address..... City and State.....

FOR RUGGED DESIGN

TROUBLE-FREE OPERATION . . .

Choose HYGRADE DRIVES!

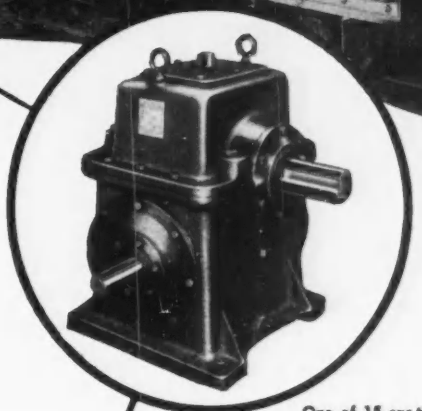


Here is a sturdy, compact Hygrade Worm Gear Drive transmitting power for moving heavy cars in and out of a large annealing furnace.

Such tough service is typical of the demands industry is making on Foote Bros. Hygrade Drives. These drives are built for rugged duty — day after day — year in and year out. Precision-processed worm gearing assures highest efficiency and optimum load-carrying capacity. Compact design gives maximum performance in minimum space.

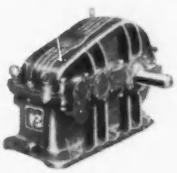
Solve your tough speed reduction problems with Enclosed Hygrade Drives. Horizontal and vertical types available. Ratios to 4,108 to 1, capacities to 260 h.p. For applications requiring long, unsupported output shafts, use Vertical Hygrade in Hytop design.

See your Foote Bros. representative or write for information

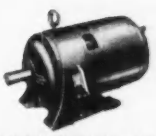


One of 15 car-type furnaces using Hygrade Drives at Warren, Ohio, plant of Copperweld Steel Company. Installed by Pennsylvania Industrial Engineers Division, Amsler Morton Co.

LINE-O-POWER DRIVES



MAXI-POWER DRIVES



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Better Power Transmission Through Better Gears

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Please send me a free copy of Bulletin HGB on Foote Bros. Hygrade Worm Gear Drives.

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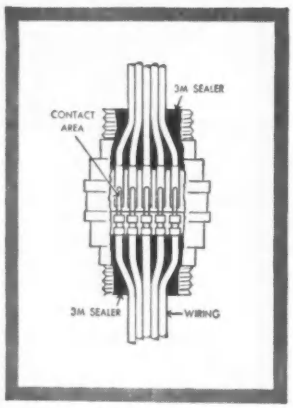

Keeping your power dry!

Protecting our shores from invasion is only one of the jobs assigned to Navy aircraft. Another task, equally important, is for the plane to protect itself against its own "natural" enemies.

For instance, consider the possible effects of salt air and water, of moisture condensation, of vibration on the electric wiring that delivers power throughout the plane. How quickly these elements would destroy the aircraft—if not checked.

To help protect these power lines, 3M, working with McDonnell engineers and the U.S. Navy, developed EC-1120—a potting compound, not affected by vibration, that provides a permanent seal for wiring in plugs against moisture and salt air. It helps to keep your power dry!

See what adhesives can do for you . . .

There are virtually thousands of other 3M products developed for specific uses such as this, or for more general purposes. For the facts on 3M adhesives, sealers and coatings designed especially for industrial use, call in your 3M sales representative, or write directly to 3M, Dept. 46, 411 Piquette Ave., Detroit 2, Michigan.

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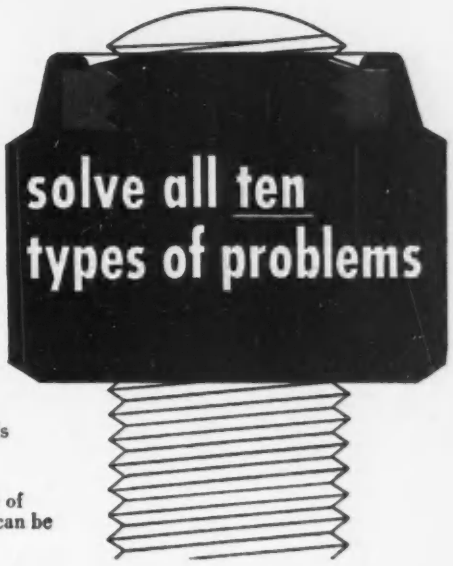
elastic stop nuts solve all ten types of problems

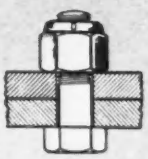


Here are ten typical fastening problems. One device, the ELASTIC STOP nut, solves them all—without additional parts or operations. Deliberately undersized in relation to bolt diameter, the red elastic collar grips the bolt with a perfect fit, exerting a continuing self-locking pressure against the threads, and holding the nut securely in place at any point on the bolt. It also provides a tight seal against the bolt threads, which prevents seepage and wear-producing axial play. And because the bolt threads are protected against moisture from without, the nuts are not "frozen" to the bolt by corrosion.

ELASTIC STOP nuts stay tight, right where you put them, in spite of vibration and stress reversals. Yet they are not jammed in place, and can be removed with a wrench and reused many times.

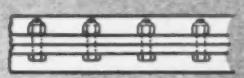
For further information on ESNA self-locking fasteners, mail the coupon below.

TIGHTENED AGAINST THE WORK



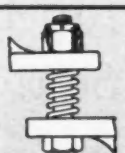
Wherever a vibration or impact proof bolted connection is desired.

On all electrical terminals subjected to vibration in transit or operation.

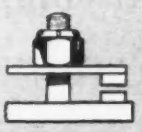


For uniform and precise prestressing of multiple bolt assemblies . . . adjusted by predetermined wrench torques.

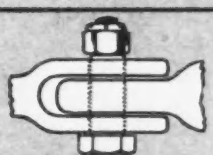
LOCATED ANYWHERE ON THE BOLT



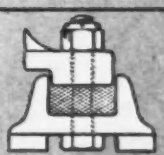
Spring-mounted connections or dynamic balancing, where nut must stay put yet be easily adjusted.



On make-and-break adjustment studs where accurate contact gaps are required.

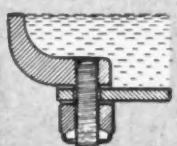


For bolted connections requiring predetermined play.

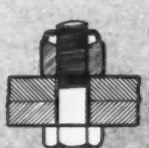


For rubber-insulated and cushion mountings where the nut must not work up or down.

FOR MANY SPECIAL APPLICATIONS



To seal bolt threads where elimination of leakage past stud threads is necessary.



To seal bolt threads where it is necessary to protect them from corroding elements.

To obtain delicate adjustments for applications such as bearing locknuts where precise adjustment is essential.

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. N41-62, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send the following free fastening information

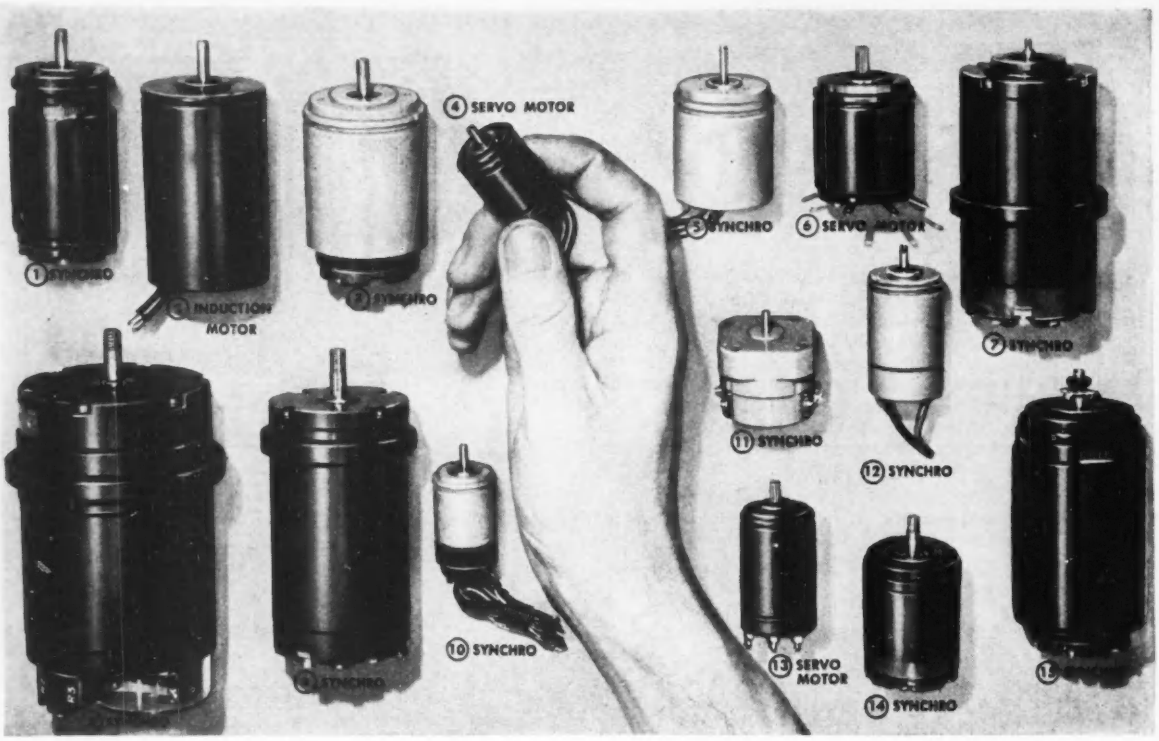
☐ Elastic Stop nut bulletin ☐ Here is a drawing of our product. What self-locking fastener would you suggest?
☐ Rollpin bulletin

Name _____ Title _____

Firm _____

Street _____

City _____ Zone _____ State _____



Ketay gives you a complete variety of sizes and types of Synchros and Servo Motors

WHATEVER THE NEED CHOOSE KETAY!
Available as listed

1. SYNCHRO, Size 16, O.D. 1.537", 115 V, 400 Cycles *(Transmitter, Receiver, Control Transformer)*
2. INDUCTION MOTOR, O.D. 1.750", 3 phase 2 Pole, 115 V, 60 Cycles
3. SYNCHRO, Size 18, O.D. 1.750", 115 V, 400 and 60 Cycles *(Transmitter, Receiver, Differential, Control Transformer)*
4. SERVO MOTOR, O.D. .937", 26V, 400 Cycles
5. SYNCHRO, O.D. 1.437", 14.4 V and 26 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
6. SERVO MOTOR Mk 7, O.D. 1.437", 115 V, 400 Cycles
7. SYNCHRO, Type 1F or 1HG, O.D. 2.250" 115 V, 60 Cycles *(Receiver, Transmitter)*
8. SYNCHRO, Size 31, O.D. 3.10", 115 V 400 and 60 Cycles *(Transmitter, Receiver, Differential, Control Transformer)*
9. SYNCHRO, Size 23, O.D. 2.250", 26 V and 115 V 400 & 60 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
10. SYNCHRO, O.D. .937", 26 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
11. LINEAR TYPE CONTROL TRANSFORMER, O.D. 1.625", 26 V, 400 Cycles
12. SYNCHRO, Size 11, O.D. 1.062", 26 V and 115 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
13. SERVO MOTOR, O.D. 1.062", 115 V, 400 Cycles
14. SYNCHRO, Size 15, O.D. 1.437", 26 V and 115 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
15. SYNCHRO, Size 19, O.D. 1.90", 115 V, 400 Cycles *(Transmitter, Receiver, Control Transformer)*

KETAY offers high precision rotary and instrument components for most every need in the Armed Forces and Industry. As the world's largest producer of government approved synchros, Ketay stands ready to solve your problems with a complete line of synchros, servos, magnetic amplifiers, computers and control systems.

If you are searching for a specific size or type... if availability is a problem... if engineering counsel is needed... Ketay can help. Why not join us for an exploratory discussion of your particular problem. Write today to Dept. K

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555 Broadway, New York 12, N. Y.

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12833 Simms Ave., Hawthorne, Calif.

MANUFACTURE ...of precision instruments, components, and systems.

NEW RESEARCH PRODUCTS FOR METAL FINISHING

"ALKA-DEOX" DESCALING PROCESS — An electrolytic alkaline derusting and descaling process for steel and many alloy steels. Fast acting without attack on base metal. Removes smuts. Less hydrogen embrittlement than with acids. Uses Enthone Compound 134.

ACTANE 33 — A crystalline product that replaces hydrofluoric acid for many operations — etching, bright dipping of aluminum. Also used in pickling stainless steel and removing silica. Less hazardous to handle than HF.

COMPOUND NR-28 — A very effective water soluble rust inhibiting compound for steel. Neutral in reaction. A powdered material used 1 - 2 oz/gal.

COMPOUND NR-37 — An organic material added to cold or hot water to prevent rusting of steel, cast iron and *porous* iron including powdered iron parts during storage or during drying of the water film. Leave no residue after the water has evaporated.

DESCALER 2A — A powdered acidic compound added to water to make pickling solutions for iron and steel. Safer to handle than sulphuric acid. Gives controlled acidity to prevent overpickling. Contains surfactants to promote more uniform and cleaner pickling.

ENAMEL STRIPPER 95 — An emulsifiable solvent type stripper for uncured lacquers and enamels. Can be used for stripping uncured materials from defective work and is also used for cleaning of spray paint booths and spray equipment. Overcomes hazards of the use of thinners for cleaning purposes.

ENTHOX — Chromating process for zinc and cadmium. Very easy to use and economical. Stops corrosion in damp atmospheres and in salt fog. If you have trouble meeting salt spray specifications on zinc and cadmium use Enthox.

ETCHALUME 14 — A new fast etching, uniform acting, alkaline cleaning and etching agent for aluminum to prepare it for painting or to procure a final etched finish.

ZINC DIE CASTING STRIPPER (COMPOUND L-88) — An electrolytic stripper for removing chromium, nickel and copper from zinc base die castings. Leaves the die casting in a clean condition ready for refinishing.

Write for check list of literature on more than sixty products and processes for modern metal finishing.

METAL FINISHING PROCESSES

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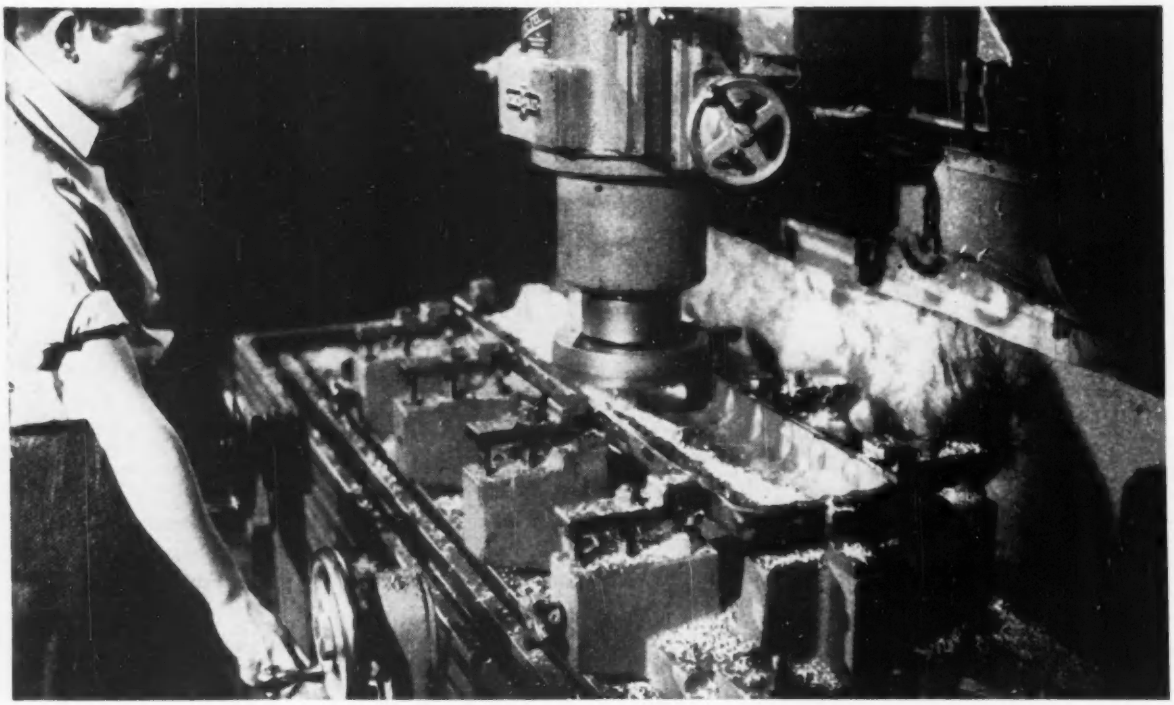
INCORPORATED
442 ELM STREET
NEW HAVEN, CONNECTICUT

ELECTROPLATING CHEMICALS

DOW

MAGNESIUM OFFERS YOU SUPERIOR MACHINABILITY

Increased tool life and lower machining costs are possible



Of all structural metals, magnesium is the easiest to machine. Heavier depths of cut and higher rates of feed than are used on other metals are possible when machining magnesium.

With increased machining speeds, magnesium helps you realize savings in production costs, particularly when extensive machining operations are required.

Magnesium cuts freely, too, assuring increased tool life. In fact, the life of high-speed steel cutting tools when machining wrought magnesium equals the life of carbide-tipped tools on other metals.

Excellent surface finish is obtainable when machining magnesium because there is no tendency for metal to tear or drag. Extremely accurate parts with dimensional tolerances of only a few ten thousandths of an inch can be made by standard machining operations.

Free Book: "MACHINING MAGNESIUM". This fact-filled book will give you complete data on all machining operations with magnesium. It also includes information on tool design, coolants and shop practice. For your copy, call your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, *Magnesium Department*, Midland, Michigan.

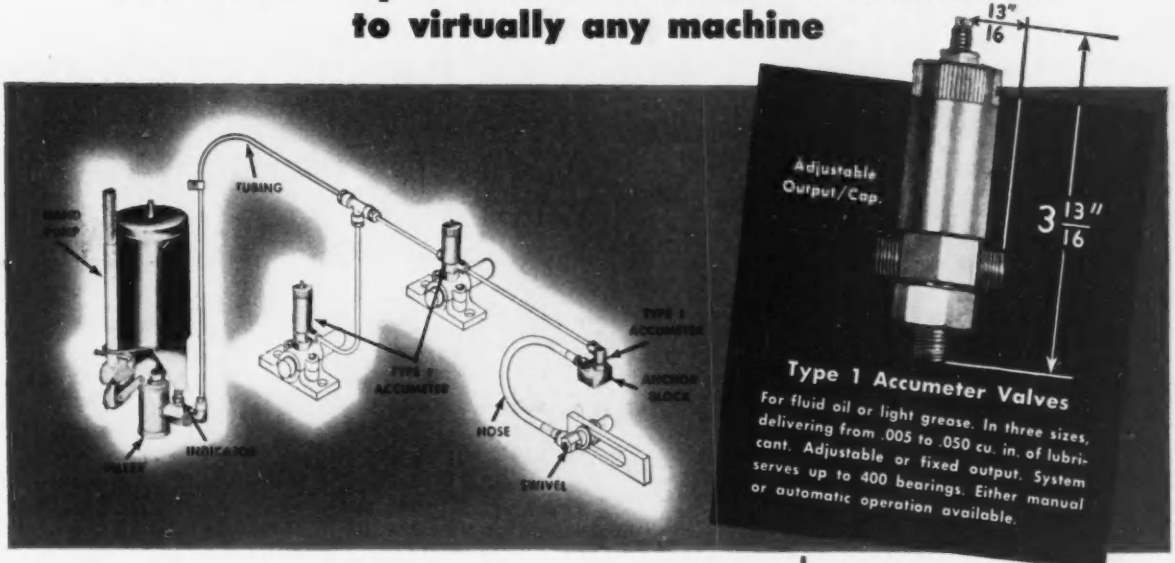
you can depend on DOW MAGNESIUM

DOW

Designed... **to eliminate hit-or-miss machine lubrication**

ALEMITE Accumeter® CENTRALIZED LUBRICATION

extends the protection of automatic lubrication to virtually any machine


TUBING
HAND PUMP
TYPE I ACCUMETER
ANCHOR BLOCK
TYPE I ACCUMETER
HOSE
FILLER
INDICATOR
SWIVEL
13" 16
Adjustable Output Cap.
3 13/16"
Type 1 Accumeter Valves
For fluid oil or light grease. In three sizes, delivering from .005 to .050 cu. in. of lubricant. Adjustable or fixed output. System serves up to 400 bearings. Either manual or automatic operation available.

Centralized lubrication with Alemite Type I Accumeter can make your machines produce more, last longer, and cost less to run—*impressive savings at low cost!* This simple, single-line system is completely versatile—easy to design, easy to build into any machine because valves fit directly on bearings, replacing grease fittings, oil cups or reservoirs.

In seconds, in a fraction of the time required for hand lubrication, Alemite Accumeter Lubrication System delivers the exact, measured amount of clean oil or grease *from one central point* to all bearings of a machine. The machine keeps operating—no production time lost—no bearings are missed. No wonder 95% of big plants buying machine tools specify *centralized lubrication!*

Type 1 Accumeter Systems serve single machines or groups of machines with semi-automatic or fully automatic lubrication. It is just one of three types of Accumeter Systems made by Alemite to meet your exacting requirements.

offers...

ALL THESE ADVANTAGES!

- **Eliminates shutdown time for lubrication. Adds productive time to machine output.**
- **Seals completely against dirt, grit, water all the way from "Barrel-to-Bearing."**
- **Prevents bearing troubles due to neglect or use of wrong lubricant.**
- **Services *all* bearings—including those inaccessible or dangerous—in one operation.**
- **Avoids work spoilage and bearing repairs due to over-lubrication.**

FACTORY-TESTED . . . FIELD-PROVED

Proved in the field. Exhaustive tests showed *no variation* in the amount of lubricant discharged . . . even after 73,312 lubrication cycles, *equal to 122 years of twice-a-day service.*

ALEMITE

REG. U. S. PAT. OFF.

A PRODUCT OF SW STEWART WARNER

Free—Alemite Accumeter Catalogue and Engineering Data Book.

ALEMITE, DEPT. T-73
1850 Diversey Parkway, Chicago 14, Ill.

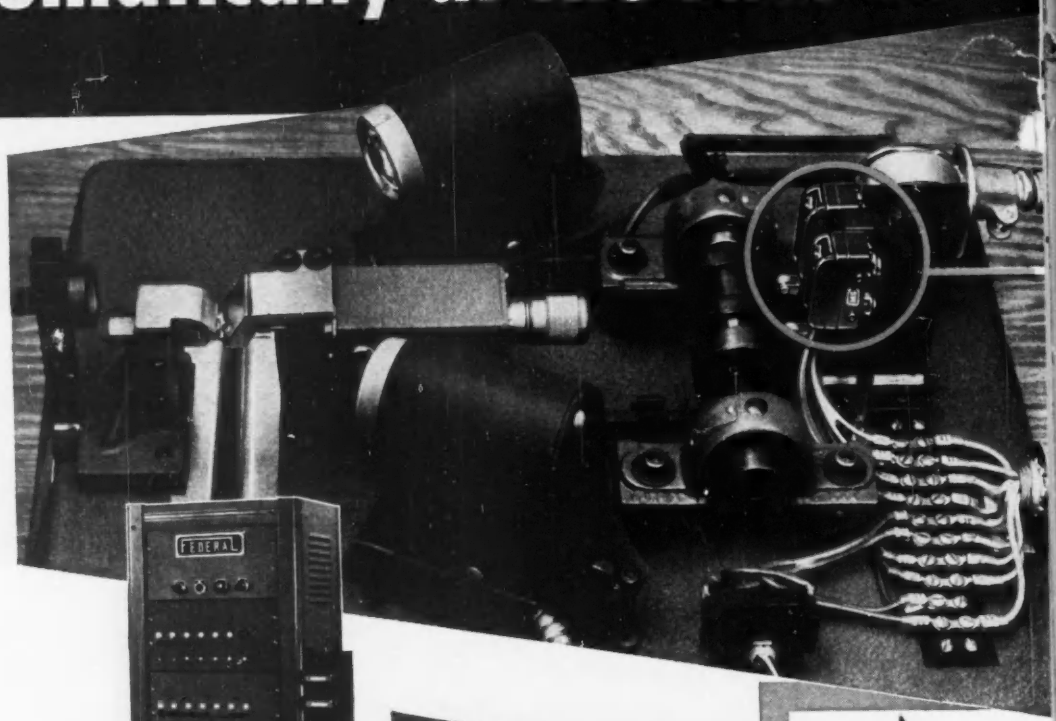
Please send me my free copy of the Alemite Accumeter Catalog

Name _____

Company _____

City _____ State _____

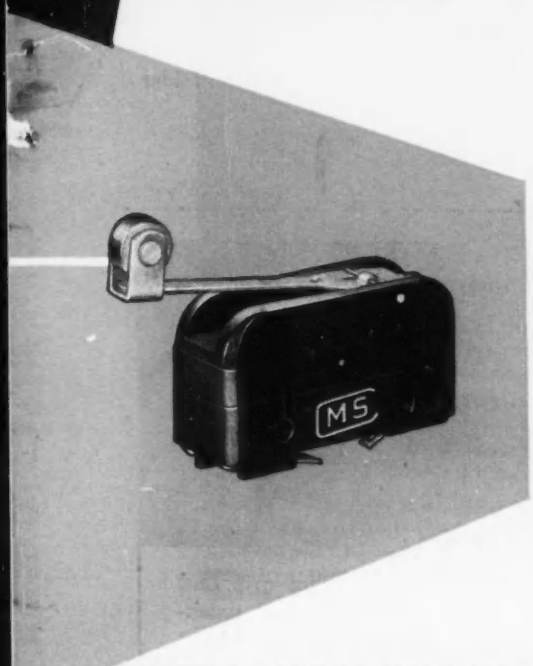
MICRO switches control gaging cycle to sort small parts automatically at the rate of



A few of 12 actuator designs of MICRO "basic" switches to meet wide variety of actuating means

Over 6000 different switches . . . each created for specific applications

60 TO 120 PIECES A MINUTE



● Two MICRO precision switches control the steps of the gaging cycle of this Federal Electronic Sorting Gage. This gage automatically sorts mica parts into eight thickness classifications at the rate of 60 to 120 a minute.

MICRO switches were selected by engineers of Federal Products Corporation for this exacting requirement because of:

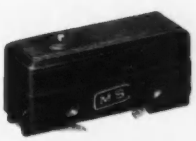
1. Extreme precision
2. Accurate repeat operation
3. Long-life dependability

The two MICRO switches are operated by timing cams to control the various steps. The gaging cycle is initiated by the operator who breaks a photoelectric beam with the mica in her hand. Then the electronic gage head moves forward, grips the mica and measures its thickness. This signal, amplified and classified, causes the correct trap door below the gage to open.

Whatever your switch application problem, there is a MICRO switch with the exact electrical characteristics, actuation means and mounting arrangements to fit your most exacting design. MICRO field engineers are at your service to help in the selection of the specific switch best suited to your requirements. We invite you to contact the nearest MICRO branch office.

All these switches have the MICRO characteristics of small size, light weight, accurate repeatability of operating point, high electrical rating and long life dependability.

Twelve designs of MICRO "basic" switches differ in respect to types of actuators to provide a wide variety of operating means. One is the "W" type of roller actuator used in the Federal electronic sorting gage. Three other types are shown here.

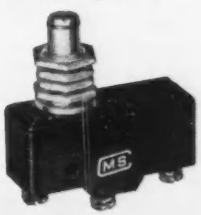


Pin Plunger Switches

MICRO pin plunger switches are designed for applications where the movement of the actuating device can be accurately controlled. They are ideal where accurate repetition of operation position is a requisite.

"QI" Plunger Switches

MICRO "QI" plunger switches are designed for mounting through panels. They are useful as manual or mechanical push button switches or for operation by slow moving cams. 7/32" overtravel is provided.



"L" Leaf Actuator Switches

MICRO "L" leaf actuator switches are designed for use in applications with operating means that combine small force with actuating movement that will limit overtravel to 1/16 inch. Cams may be used against the leaf actuator.

MICRO
MAKERS OF PRECISION SWITCHES
FREEPORT, ILLINOIS

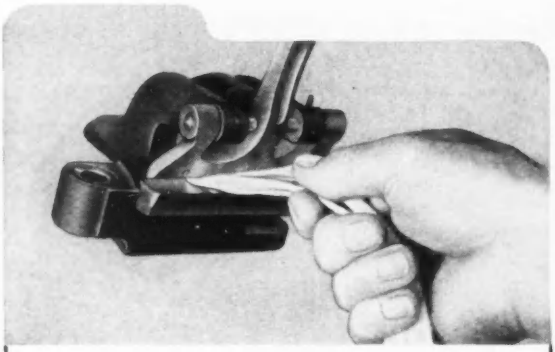
A DIVISION OF
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

FACTS
...About a Straight Chrome Stainless Steel That Shows Unusual Promise for Your Applications...

If your products or components call for the properties of a stainless steel, here is a stainless that shows unusual promise for many applications. And this steel (Carpenter No. 3, Type 443) is particularly important today for jobs requiring an improved straight chrome stainless to replace the 18-8's restricted by Government Regulations. Carpenter Stainless No. 3 gives you *excellent corrosion resistance, high resistance to scaling,* and a *low annealing temperature (500°F lower than type 304).* Moreover, No. 3 provides machinability comparable to SAE 3145, 3250 or 4650. For more information on No. 3—its mechanical properties, relative workability, corrosion resistance, recommended uses, etc.... drop us a line on your Company letterhead for the new descriptive folder on Carpenter No. 3.

Typical user reports on Carpenter Stainless No. 3

This rod end bearing for military aircraft must have heat resistance, ability to resist salt corrosion, good machinability and good cold forging qualities. *Carpenter No. 3* has met all these requirements and is giving an excellent account of itself both as to corrosion and heat resistance at operating temperatures up to 1000°F. Moreover, No. 3 is not subject to intergranular corrosion at this temperature.



These jaw inserts for tenter clips grip and stretch nylon cloth as it rolls through finishing stages. Inserts must be spotless and must resist corrosive action of the dyes because a slight surface defect could break the threads. In addition to good corrosion resistance, *No. 3* gave the inserts high wear resistance for long service—including resistance to abrasion from talc and china clay used in other textiles processed.

A word about availability...

Carpenter Stainless No. 3 (Type 443) is available from Reading Warehouse Stocks, hot rolled annealed in sizes ⅜" to 2¾" round. Other standard bar sizes and finishes, also cold rolled strip, are manufactured to order in minimum quantities of 500 pounds per size. Mill shipments are currently 60 to 120 days from receipt of order and neither priorities nor allotments are required.

THE CARPENTER STEEL CO., 117 W. Bern St., Reading, Pa.
Export Department: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

more than corrosion resistance

Carpenter STEEL — Stainless Steel

pioneers in improved specialty steels

Call your nearest Carpenter Mill-Branch Warehouse, Office or Distributor

FARVAL—*Studies in Centralized Lubrication* No. 142

FARVAL SAVES DOLLARS

and many production hours on 4 Minster presses

THE press room is the bottleneck in any sheet metal plant. If presses are shut down for oiling or repair of bearings due to faulty lubrication, the entire manufacturing operation grinds to a halt. Production is lost.

To avoid these troubles in its plant, Lyon Metal Products, Inc. installed Farval centralized systems of lubrication on their four Minster presses. The results were immediate: Farval resulted in considerable savings in labor and lubricant over a three-year period. But better than that, Farval freed these presses for their real work of high-speed, non-stop production by eliminating the "human element" involved in frequent shutdowns for lubrication. Now, with a quick stroke, all points (regardless of location) on a machine are lubricated properly, effortlessly. In addition, the Farval system is sealed against dust and scale which inevitably get into bearings with old-fashioned oiling methods.

Farval is the original Dualine system of centralized lubrication that delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, as often as desired. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble.

Today, Farval is working in hundreds of metalworking and processing shops protecting bearings on presses, coilers, shears—in fact, every type of equipment that must be lubricated regularly and properly.

If you want to lower production costs in your plant, you owe it to yourself to look into Farval. The savings will amaze you. Write today for free Bulletin 25. The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

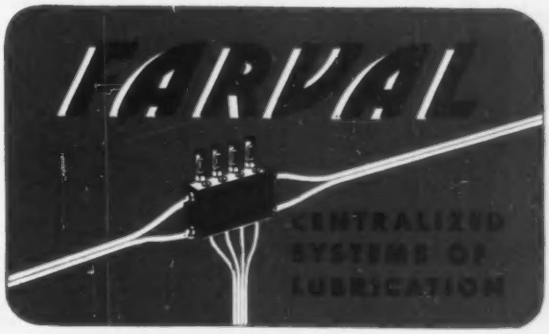
KEYS TO ADEQUATE LUBRICATION— Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know that a machine will be properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.

FARVAL SAVES ON LUBRICATING 4 PRESSES
(Savings based on one work shift per day)

	Lbs./Yr. lube. 64 points	Hrs./Yr. lube. 64 points
GREASE GUN	576 lbs.	208 hrs.
CENTRALIZED SYSTEM	144 lbs.	52 hrs.
SAVINGS EFFECTED IN 3 YEARS BY FARVAL	1296 lbs.	468 hrs.

AND IN ADDITION, FARVAL SAVES BEARING EXPENSE AND PRODUCTION TIME

Reports of lubrication engineers show lubrication by grease gun takes .747 minutes per point to clean dirt from nipples, grease, move from point to point and refill gun. With Farval it only takes .188 minutes per point to fill reservoir, build up and hold pressure, and lubricate. In addition, Farval saves 3 pounds of each 4 of lubricant used by other methods.



If your product
requires handles

Here's big news!

New Type Yale Handle Attached with INVISIBLE SCREWS

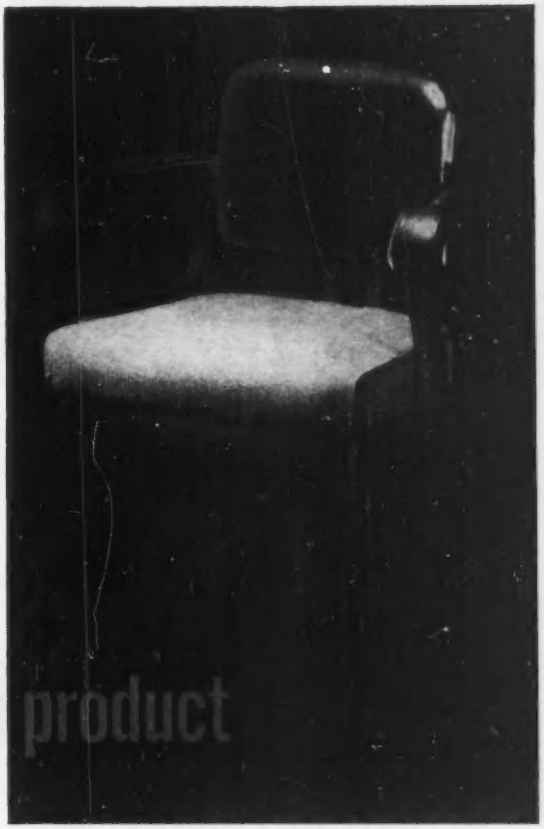
STAMFORD, CONN.—Of major interest to manufacturers whose products require handles is the new type industrial lever handle recently introduced by The Yale & Towne Manufacturing Company. Hailed as the first major development in handles in years, this new Yale handle can be attached to your unit with *invisible* screws. This feat is accomplished by a concealed attaching screw device on the rear of the door. But the invisible screw is only one of many improvements in this handle that can add so much to the product you produce. Roomier contour grip...more attractive design...polished or satin finishes as well as the extra security of a 5 disc-tumbler locking cylinder are other features that make this handle a standout. Find out more about this wonderful new type handle by writing, today, to The Yale & Towne Mfg. Co., Lock & Hardware Div., Stamford, Conn. (In Canada: St. Catharines, Ont.)

Yale is a registered trade mark

YALE & TOWNE

Your product

like this product



can be improved with

Executive chair manufactured by Sturgis Posture Chair Company is protected with their STURLON® coating for metal parts. This coating is based on VINYLITE Dispersion Resins.

VINYLITE dispersion resins
BRAND

All metal parts of this executive chair, and every other metal chair made by Sturgis Posture Chair Company, Sturgis, Michigan, are decorated and efficiently protected by their STURLON® coating based on VINYLITE Dispersion Resins.

Tests showed 10 to 20 times longer wear than baked enamels tested... greater resistance to scratches, mars, water soak and humidity... no deterioration from salt spray, detergents, cleaners, nail-polish remover, lipstick and other agents. The coating has excellent color retention. Static shock is reduced. It has a pleasant warm feel, and requires only gentle wiping to maintain its high-polish luster.

Your coating supplier can recommend formulations on BAKELITE and VINYLITE Brand Resins for practically every purpose... coatings recognized as superior in durability and service. For complete information and list of suppliers write Dept. OP-10.

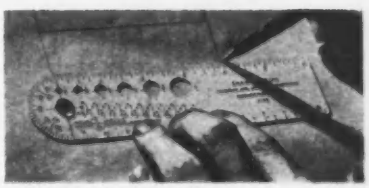
See Bakelite Company's exhibit at the Basic Materials Show, Grand Central Palace, New York, June 15-19, 1953.

BAKELITE TRADE MARK
and Vinylite BRAND
RESIN COATINGS

TRADE MARK
BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

IMPELLER HOUSING for military radio transmitter, molded of BAKELITE Phenolic Plastic, withstands vibration, shock, temperatures between −55 and +70 deg. C. Made by Whitso, Inc., Schiller Park, Ill., for Collins Radio Co., Cedar Rapids, Ia.

LONG-WEARING FEET for ironing table legs are molded of VINYLITE Plastic Flexible Compounds. They are non-skid, retain shape and resiliency, and withstand rough treatment, abrasion. Molded by Minnesota Plastics Company, St. Paul, Minn.



DRAWING INSTRUMENT made from VINYLITE Plastic Rigid Sheets is combination compass, scale, square, and protractor. It's dimensionally stable, easy to clean, resistant to moisture, oil, ink, most chemicals. By Shaw-Barton, Inc., Coshocton, Ohio.

10 U. S. Royal adhesives cover 90% of all industrial uses!

MADE FROM 4 BASE RUBBERS

RECLAIM — **NEOPRENE**

GR-S — **BUNA N**

Free booklet tells how to pick the right adhesives

This booklet makes you a specialist in adhesives. It gives you the facts a specialist needs to know about each adhesive in the U. S. Royal "10-90" series. It shows you how to select the adhesive whose characteristics best suit your requirements, according to base, thinner, viscosity, weight, bonding range and general use. And remember that the U. S. Royal line *takes care of 90% of normal adhesive requirements.* For unusual cases, "U.S." offers a complete line of "specials"—designed for particular bonding problems. Write today to address below for your copy of the U.S. Royal Adhesive Booklet.

"U.S." Research perfects it
"U.S." Production builds it
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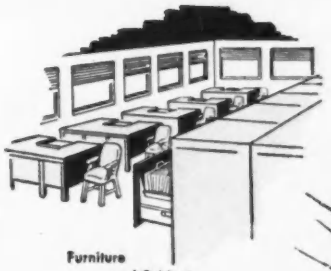

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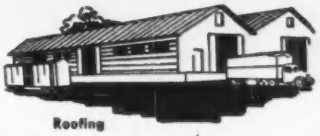

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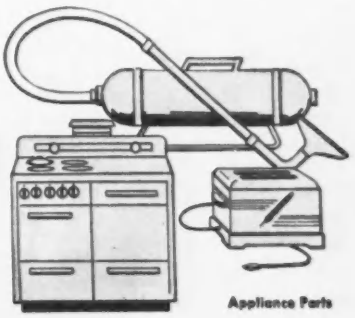
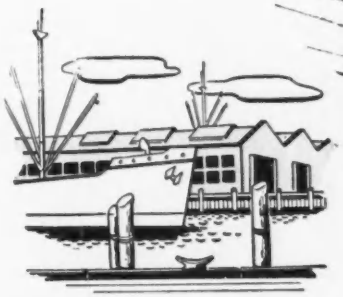


Appliance Parts



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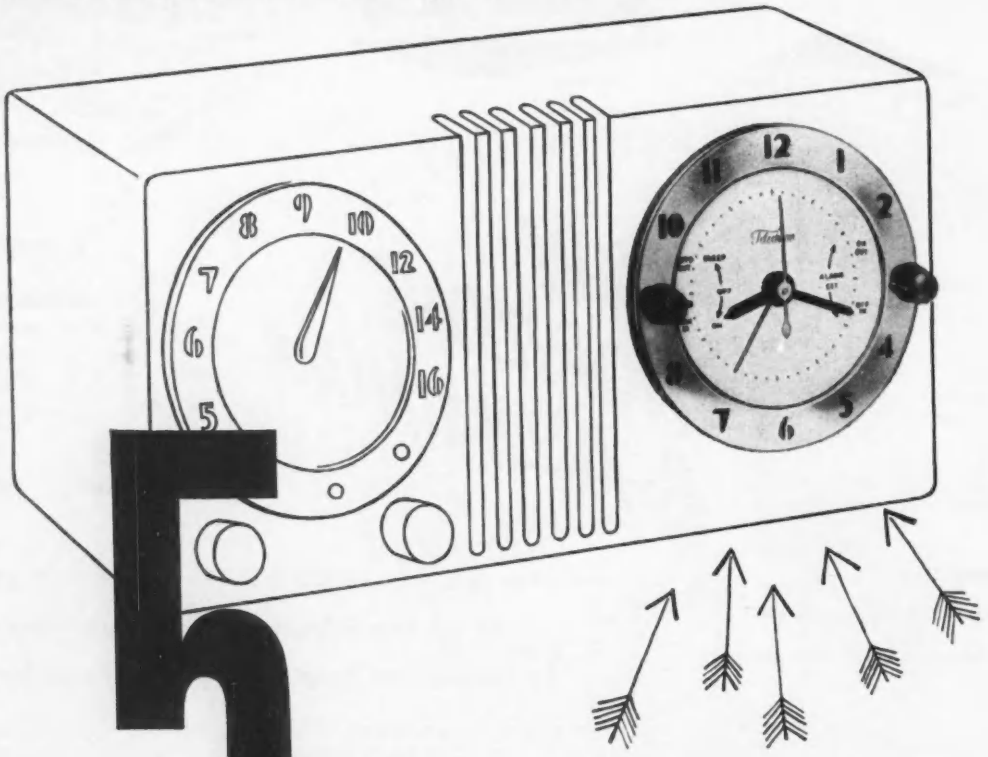

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1 TWO KNOBS do the work formerly done by three. The new Telechron Timer, model C-78, means unmatched simplicity in clock-radio operation. One knob for alarm . . . the other for radio.

2 SIGNAL ALARM. It's a must for heavy sleepers. And it's a sales-boosting extra talking point for your clock-radio. In the clock-radio field only Telechron Timers have the signal alarm.

3 RADIO ALARM "ON" SWITCH. Contacts rated at 15 A. at 115v. a-c. Adequate to carry the load of a variety of electrical appliances through an auxiliary outlet on your clock-radio.

4 DEPENDABLE SLEEP SWITCH. Simple design—friction geared to clock movement—insures accuracy, dependability, and sturdy endurance even with rough handling.

5 FREEDOM OF STYLING. Two-knob control and separate alarm hand mean greater freedom for your styling people. Telechron Timers are available with round or square face . . . any color dial, hands or bezel.

Sales-Boosting Extra Benefit

You are free to display the Telechron trade-mark and the Telechron Seal of Accuracy on your clock-radio. Ask for full information. Telechron Department, General Electric Company, 16 Homer Ave., Ashland, Massachusetts.

Telechron

MARK OF TIMING LEADERSHIP

New Bullard vertical chucking grinder gets high precision, handles heavy loads with table on TIMKEN® bearings

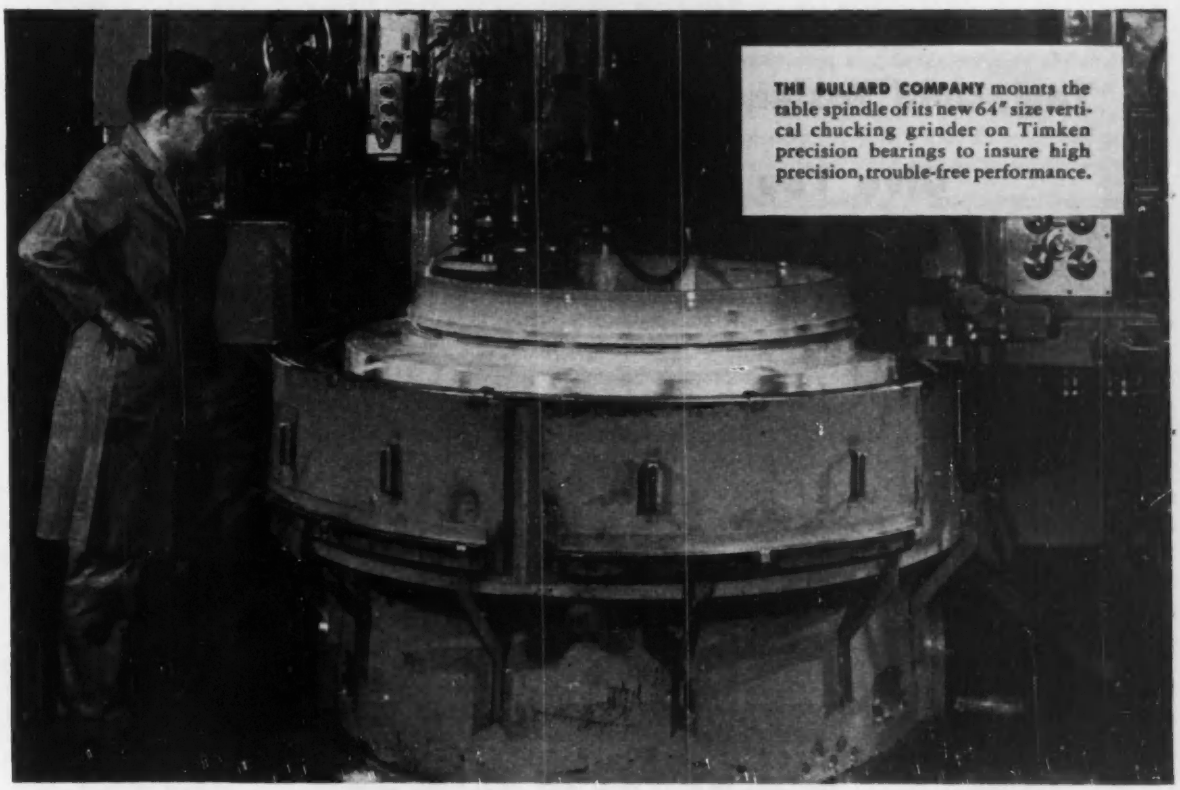
TO insure the high precision needed in finishing cups and cones for large-size roll neck bearings, Bullard mounted the table spindle of a new 64" size vertical chucking grinder on Timken® tapered roller precision bearings. Timken bearings are also used in many other vital spots.

Line contact between their rollers and races gives Timken bearings extra load-carrying capacity. Their tapered construction takes radial and thrust loads in *any* combination. Result: Shafts are held in rigid alignment. Shaft deflection and end-play are minimized. Gears mesh smoothly. Spindle precision is assured.

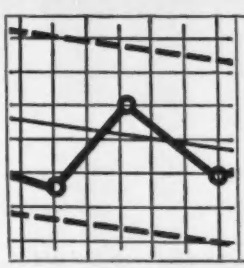
True rolling motion and an incredibly smooth surface finish make Timken bearings practically friction-free. Maintenance and lubrication time and costs are cut to a minimum.

Precision manufactured, made of Timken fine alloy steel and engineered for the job, Timken bearings normally last the life of the machine. Specify Timken bearings in the machinery you build or buy. Look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



THE BULLARD COMPANY mounts the table spindle of its new 64" size vertical chucking grinder on Timken precision bearings to insure high precision, trouble-free performance.



STATISTICAL QUALITY CONTROL

To insure uniform high quality and closer tolerances, the Timken Company uses statistical quality control. With it, tolerance deviations are plotted graphically. It's one of industry's newest, most scientific methods of improving product uniformity.

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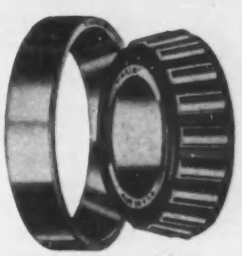
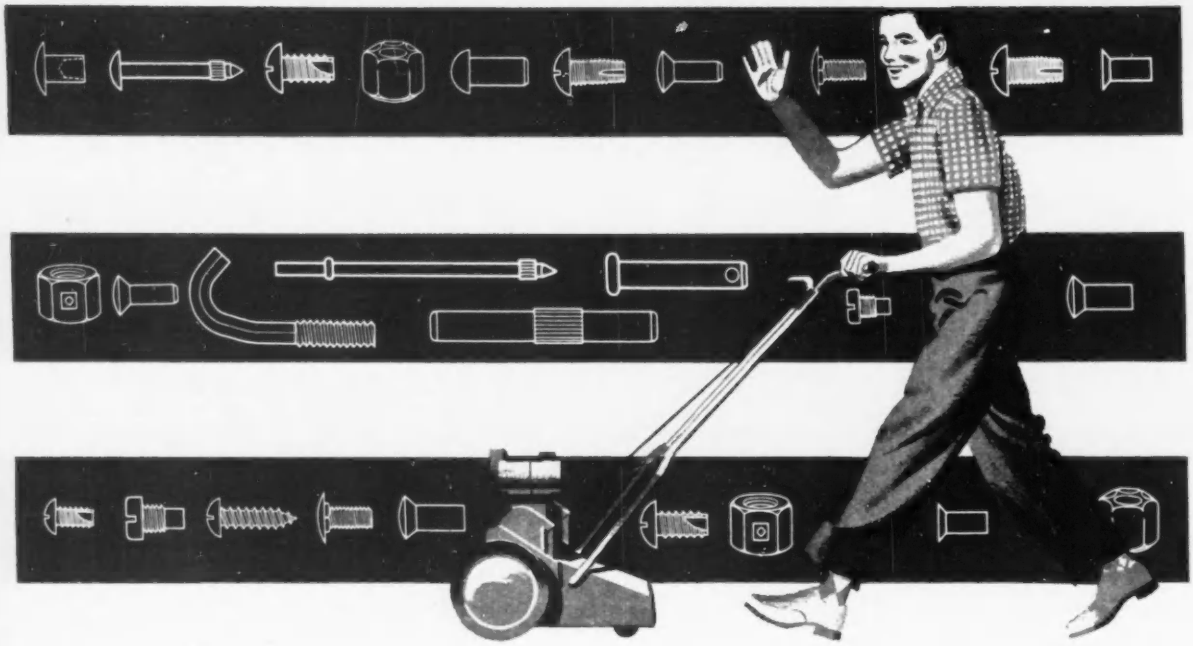


NOT JUST A BALL — NOT JUST A ROLLER — THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST — LOADS OR ANY COMBINATION



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Imagine the joy of power mowing without the continual annoyance of having parts jiggle loose, drop off and get lost in the grass. To assure you hours of easy, carefree mowing, many manufacturers use Townsend fasteners—which are designed to stay put—hold components together permanently. Townsend locknuts, self-tapping screws, rivets, pins, and special fasteners not only provide tight, fast, secure assembly but reduce material and labor costs as well.

In other industries, leading companies recognize Townsend as "The Fastening Authority" and depend upon our design engineers to solve innumerable assembly problems.

They know the Townsend method of designing and cold-forming special fasteners and parts has improved products, reduced material costs and speeded assembly. Savings are substantial—ranging from $5,000 to $20,000 a year—as high as $80 per thousand on a single part.

In your quality-improvement, cost-reduction program you can have the benefit of Townsend's 137 years of designing cold-formed parts—draw upon its capacity of 60-million pieces daily for service—choose from over 10,000 standard and special items for proper application to the problem. Send drawing or samples of the parts you wish improved in order to reduce unit costs. Our fastening specialists will give you the solution without obligation.

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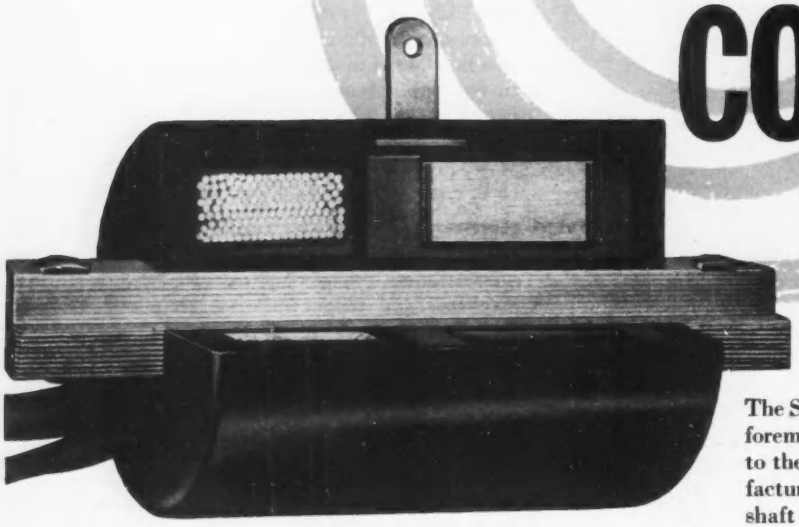

The Scintilla Magneto Division of Bendix, foremost supplier of ignition equipment to the aviation industry, offers the manufacturer of small industrial engines crankshaft and flywheel magnetos with a new and exclusive high output coil that adds immeasurably to engine performance.

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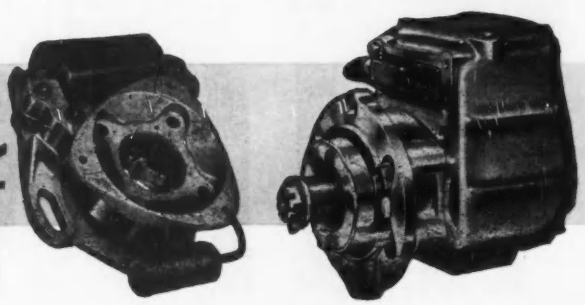

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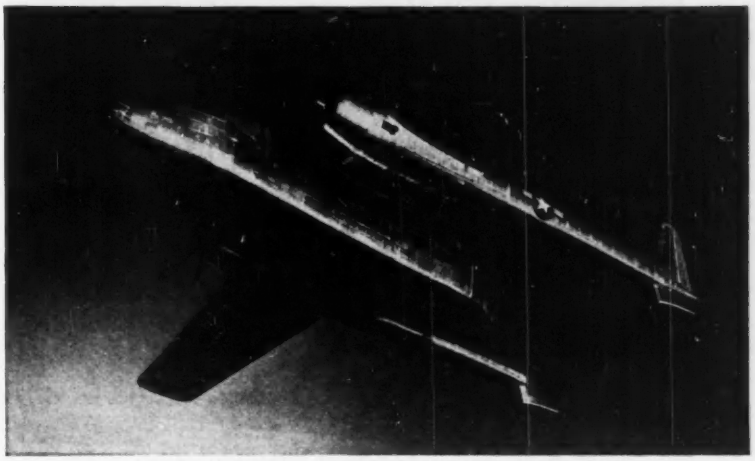
Rugged Duronze Fittings Chosen for Flying Boxcars



Fairchild C-119 Flying Boxcar, standard medium USAF transport.

Bridgeport's Duronze III is playing an important role in the manufacture of Fairchild C-119 Flying Boxcars. Items such as bulldozers, trucks, 155 millimeter howitzers, jeeps, lifeboats, helicopters, ambulances and steamrollers fit easily into the cavernous holds of these twin-boomed aerial carryalls. Rugged construction is necessary, because the C-119 must deliver sustained high performance under severe conditions.

Advantages of Duronze III

Searching for a tough, hard metal for bushings, screws, nuts and other fittings, the Fairchild engineering department decided on Bridgeport's Duronze III, silicon aluminum bronze, 707. It contains approximately 91% copper, 7% aluminum, and 2% silicon. This engineering alloy was chosen in preference to other metals because of its unusually fine physical properties:

- ...the remarkably high tensile strength of approximately 90,000 psi and a Rockwell hardness of B85 in the annealed condition.
- ...excellent resistance to corrosion.
- ...about 9% lighter than Naval brass.
- ...free machining—60% rating as compared with free cutting brass.

This hard, strong alloy has fine wear resistance when used for sliding parts. It can readily be hot forged at a temperature slightly higher than that used for brass.

Duronze III Parts Used in Flying Boxcars

The illustration below shows the following parts:

(1), (3) Nuts used on engine control panel.

(2) Split bushing for nose landing gear trunnion support.

(4) Bushing used in nacelle and fuselage.

(5) Bushing for emergency escape hatch block assembly handle.

(6) Support collar used on leveling jacks on ground handling equipment.

(7) Threaded collar for leveling jacks on ground handling equipment.

(8) Bushing for engine control pedestal.

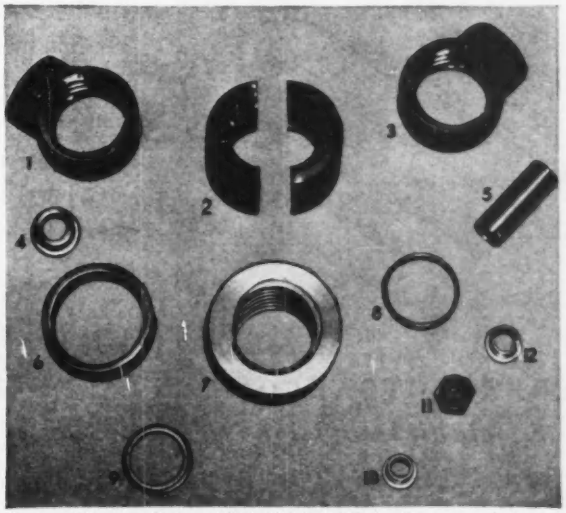
(9) Bushing for fuselage floor roller.

(10) Bushing for nacelle door actuator push rod.

(11) Bushing for master cylinder, brake system (covered with glue to prevent threads being scratched until installed).

(12) Bushing for life raft release load reducer.

Not illustrated are Duronze III trunnions of throttle stop mechanisms which are installed on engine control pedestals.



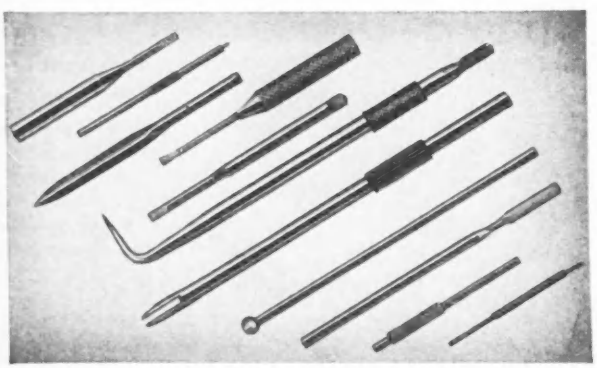
Parts used in manufacture of Fairchild C-119 Flying Boxcars made from Bridgeport's Duronze III. Courtesy Fairchild Aircraft Division, Hagerstown, Maryland.

Technical Assistance

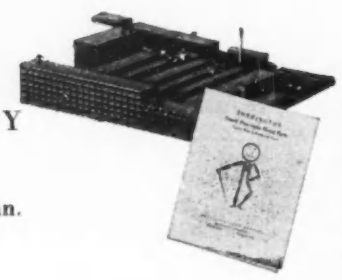
If you are planning to upgrade the quality of your products by changing your metal specifications, contact our nearest district office for technical assistance. We will be glad to supply information on Duronze III—physical properties recommended, machining methods and suggested applications. Write for your free copy of Bridgeport's "Duronze Manual" today—on company stationery, please. (9839)

There's profit in it for you!

Let Torrington make your small precision metal parts



If your product uses special pins, pivots, dowels, needles, mandrels, knives or other small precision metal parts, TORRINGTON can make them better, faster, less expensively than you can. Specially-designed automatic machinery draws, grinds, swages, knurls, slots, bevels and rolls threads on production runs to high precision standards.



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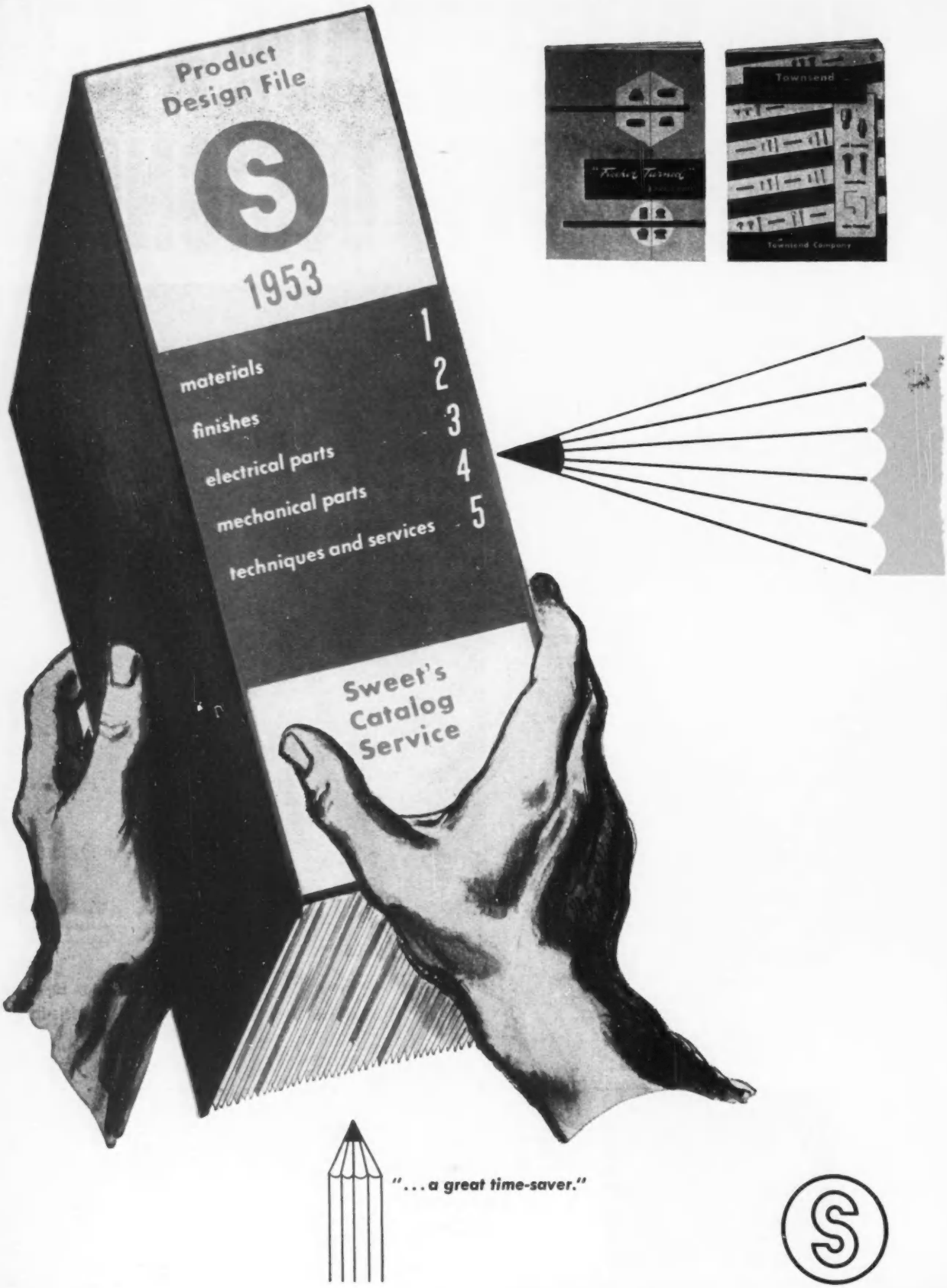
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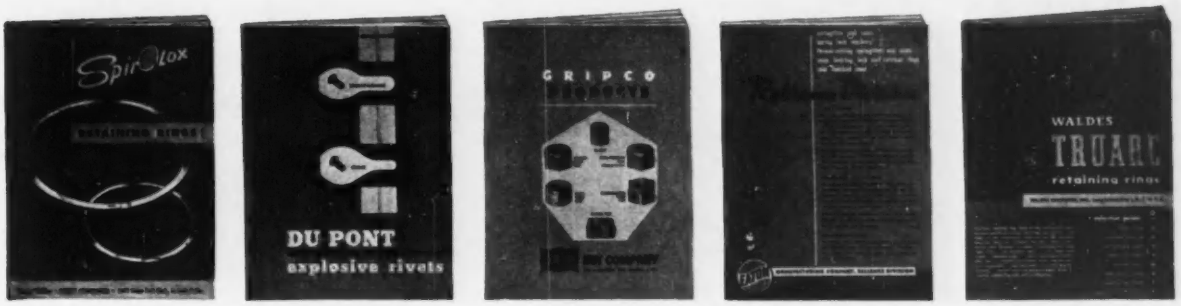

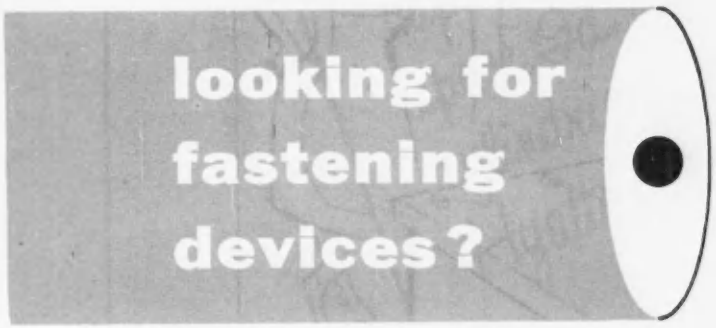

reach for your Product Design File

These manufacturers' catalogs—containing comprehensive information on metal stitching, aluminum fasteners, screw machine products, rivets, lockwashers, retaining rings, nuts, lock nuts, socket screw products, self tapping screws, "Spin-Lock" screws, patented metal fasteners, wood screws, and other fastening devices—are instantly available in Section 4k of your Product Design File.

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This collection of 201 manufacturers' catalogs is grouped in sections according to products, or use of products, so that you can readily compare one product with another. Indexes of manufacturers, products and trade names lead you quickly and easily to the catalogs you are looking for.

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DIVISION OF
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What's Screwy? by Phillips

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FREEDOM FROM DRIVER SKIDS is just one of the advantages of Phillips Screws. No danger of marring the finish. In addition, they drive in much faster. And they add to the structural strength of the product, too — set up tighter and resist loosening under vibration.

The identifying X on the cross-recessed-head identifies the X-tra quality of Phillips Screws at a glance. Be sure to specify "Phillips."

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X marks the spot... the mark of extra quality

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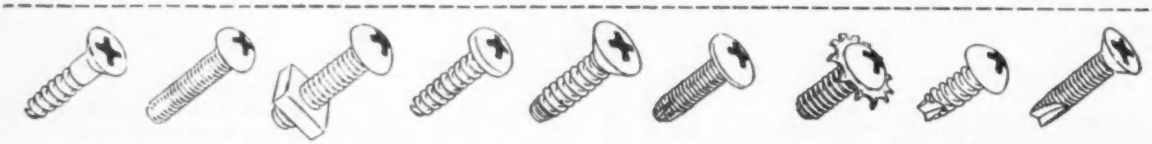
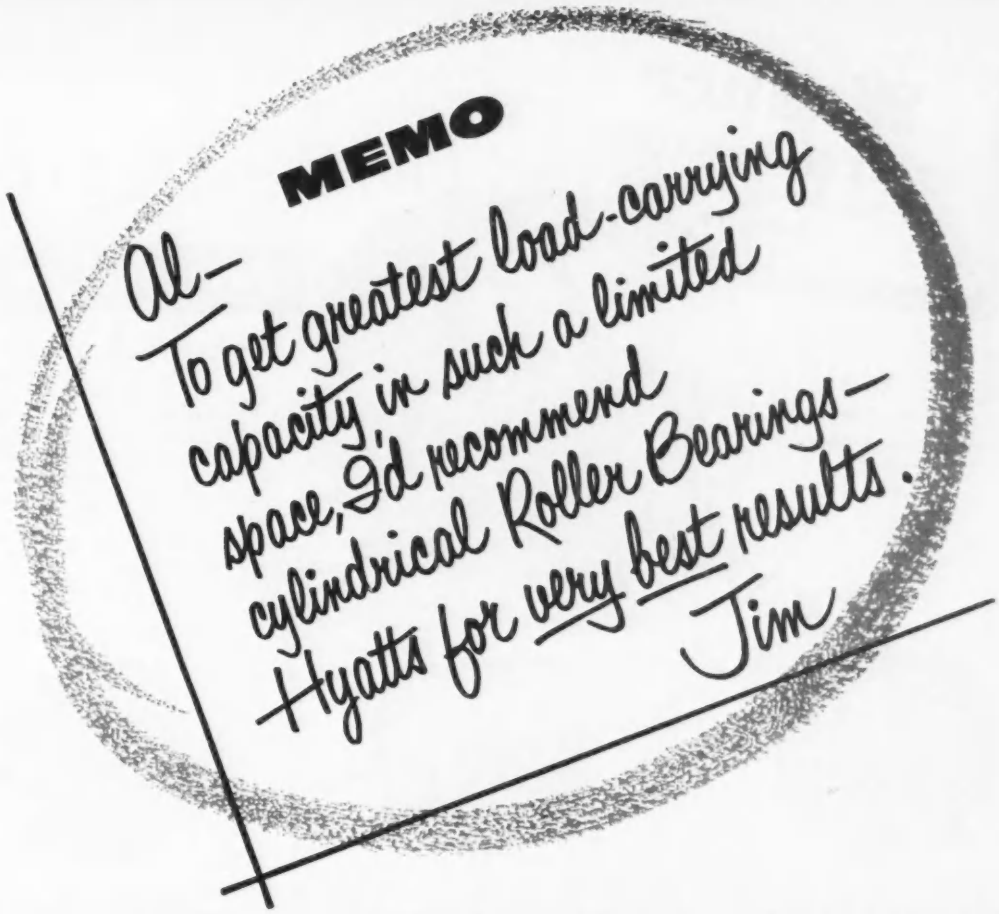
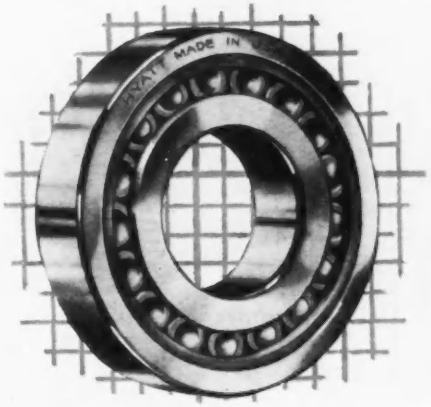


TODAY'S...AND THE FUTURE'S...FINEST FASTENER


MEMO
Al—
To get greatest load-carrying capacity in such a limited space, I'd recommend cylindrical Roller Bearings—Hyatts for very best results.
Jim

It's a Matter of BETTER DESIGN!



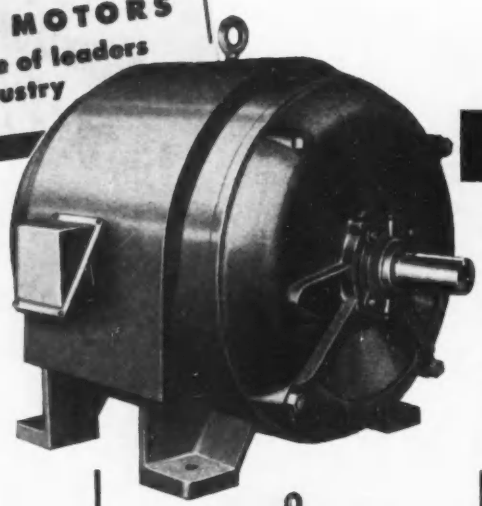
"Jim" has the right answer. The one best way to handle radial loads is to design with *cylindrical roller bearings!* And if you're looking for the very best operating results, specify *Hyatt* Roller Bearings!

Within given boundary dimensions, you achieve maximum radial load carrying capacity—and longest bearing life—by using radial roller bearings. No load-carrying capacity is sacrificed to provide for other conditions, and more practical design and simplified assembly procedures usually result. And, when you work with *Hyatts*, you have the additional advantage of *greater design flexibility*, because Hyatt offers the most complete line of radial roller bearings available anywhere—with more than 800 bearing sizes in the Hy-Load series alone!

If you aren't already profiting through the use of Hyatts, write for our general catalog, No. 150. It will put the answer to *any* bearing problem at your fingertips. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

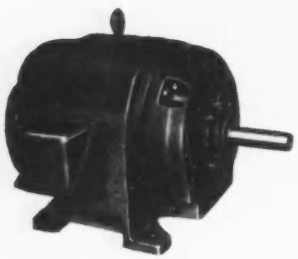
Wagner
ELECTRIC MOTORS
...the choice of leaders in industry



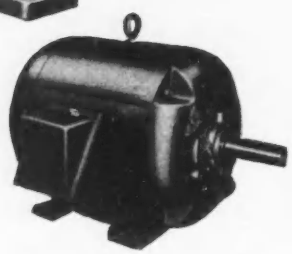
Type of construction used on RP Motors in frame sizes larger than 505.

POLYPHASE MOTORS

Whatever your motor requirements may be—single-phase or polyphase . . . 1/125 hp or 400 hp—Wagner can offer a standard motor that is entirely dependable in its specific application. The wide variety of motors shown here is typical of the many motors and motor modifications in the complete Wagner line. At left is TYPE RP — open type polyphase squirrel-cage motor. It is drip-proof and suitable for all general purpose applications. 1/6 to 400 hp.

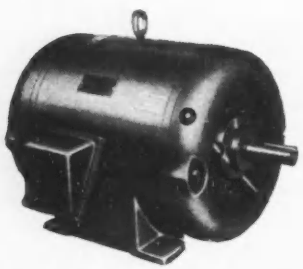


TYPE XP — Splashproof. Protected against splashing or dripping liquids. 3/4 to 200 hp.

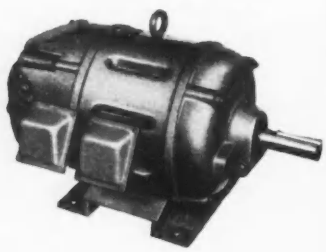


TYPE CP — Totally-Enclosed Fan-Cooled. Protected against dirt, chips, abrasives or fumes. Steel frame, 2 to 250 hp. Type HP explosion proof.

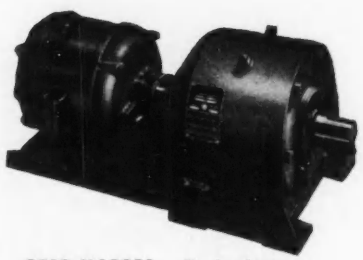
TYPE TP — Totally-enclosed, non-ventilated. Fully protected. Steel frame, 1/4 to 15 hp; cast iron frame, 1/2 to 1 1/2 hp.



TYPE EP—Corrosion-resistant. Totally-Enclosed Fan-Cooled. Cast iron frame, 2 to 250 hp. Also available in explosion proof type JP.



TYPE RS-1 — Wound Rotor. Constant or adjustable varying speed. 1 to 250 hp. **TYPE RS-2** for intermittent service. Crane and hoist type, 2 to 200 hp.



GEAR MOTORS — Single-phase or Polyphase. Open or enclosed types. 1/2 to 50 hp.

Wagner Electric Corporation EST. 1891

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ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

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Wagner Quality Motors

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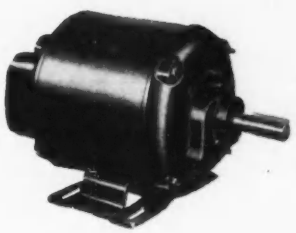
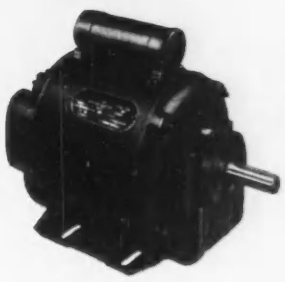
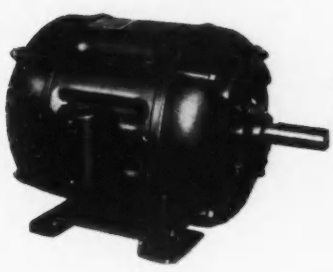
SINGLE-PHASE MOTORS



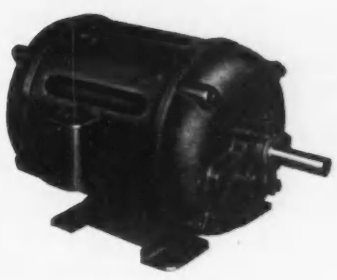
TYPE RB — Split-phase Induction. For easy starting applications with high starting current. 1/20 to 1/3 hp.



TYPE RK — Capacitor-Start Induction. For general purpose applications requiring high starting torque—normal starting current. 1/6 to 5 hp.



TYPE RG — Repulsion-Induction. For high starting torque applications involving a very long starting period. 1 to 5 hp.



TYPE RA — Repulsion-Start Induction. For general purpose applications with high starting torque—low starting current. 1/2 to 15 hp.

Here's why so many leading manufacturers

choose Wagner Motors as standard equipment:

1. For more than 60 years, Wagner Motors have been establishing records for giving users continuous, troublefree performance.
2. The high quality of Wagner Motors is a *known* factor—they help give product acceptance.
3. The many types and modifications of standard Wagner Motors help the designing engineer to select the *right* motor for every job.
4. A nationwide sales and service organization (25 Wagner-owned Service Branch Warehouses and more than 750 Authorized Service Stations) provide on-the-spot service, replacement motors, or genuine Wagner motor repair parts.

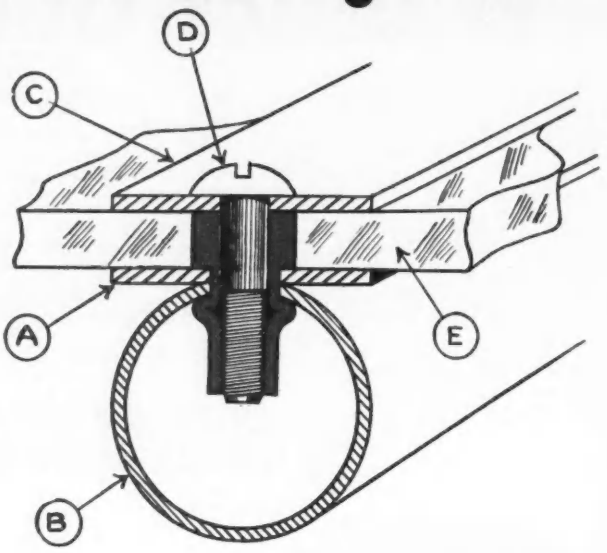
Why not consult your nearby Wagner engineer on your next motor application? Bulletin MU-185 gives complete information—write for your copy.

B. F. Goodrich RIVNUTS fasten plastic to tubular post, make weather-tight seal!

TO PROVIDE a neat, tight seal for airplane windows, designers needed a simple, one-piece fastener—a blind rivet and nut plate combined. They found the ideal answer in a spacer-head B. F. Goodrich Rivnut.

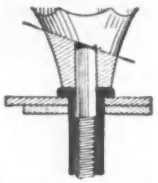
With the easy-to-use heading tool, one man quickly upset the Rivnut, securely riveted plate "A" to tubular center post "B". The firm bulge formed in the Rivnut shank conformed to the curvature of the tube. The Rivnut head served as a spacer for transparent plastic sheets "E". Screw "D" was then threaded into the clean, still-intact Rivnut threads to hold clamp strip "C" and plastic sheets in place.

Besides providing a tight, dependable seal, Rivnuts saved many man-hours on this job. If you're looking for a fastener which can improve your product and cut production time, why not get the facts from a Rivnut engineer? Write The B. F. Goodrich Company, Department A-37, Akron, Ohio.

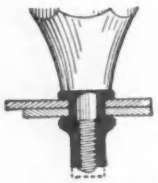


Rivnuts provide at least 6 clean threads in one simple operation!

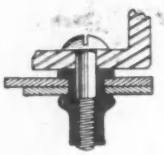
1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2 Rivnut is inserted—head firmly against work—tool at right angles to work.



3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

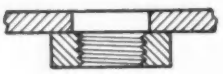


4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

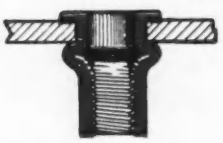
Compare these 4 methods of putting screw threads in thin sheet metal

Tapped—2 threads

Pierced and tapped—3 threads



Projection welded—4 threads



Rivnut—at least 6 threads

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Shows with motion how Rivnuts work. Explains construction, gives proved applications. Write to The B. F. Goodrich Co., Dept. A-37, Akron, Ohio.

NO. TEN OF A SERIES

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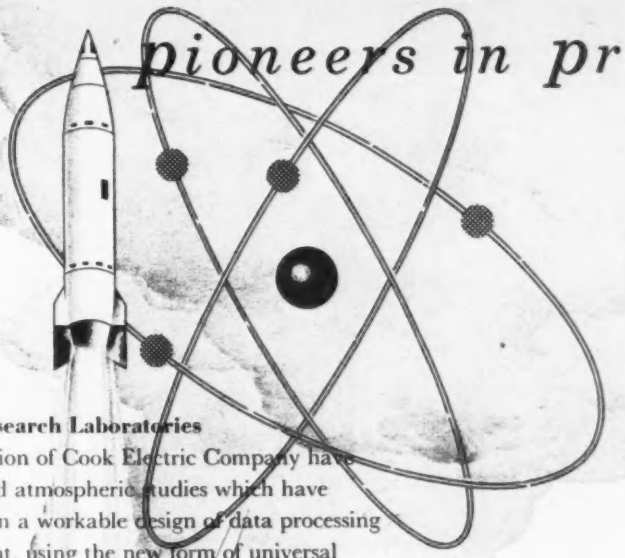


Cook Research Laboratories

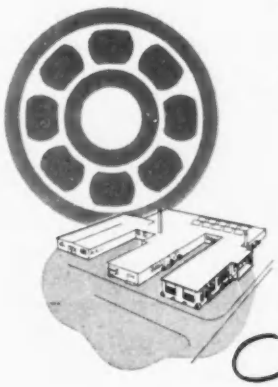
a Division of Cook Electric Company have conducted atmospheric studies which have resulted in a workable design of data processing equipment, using the new form of universal records developed by this post-war pioneer in laboratory testing techniques.

Miniature Precision Bearings

incorporated, are the originators and pioneer developers of radial ball bearings in miniature sizes. More than twenty years ago, MPB engineers developed the first miniature radial ball bearings with ground races. From an original group of five ball bearings, MPB has developed a comprehensive line of more than 130 types and sizes, many of which now form the basis for international standardization.

Thousands of contemporary problems involving space, weight, and friction are being solved by the extensive variety of MPB ball bearings. They are fully ground, lapped, and/or honed to ABEC 5 tolerances or better. MPB ball bearings are torque tested, ultrasonicly cleaned, supplied in specific tolerances and classified within the tolerances for prompt assembly and maximum service. MPB ball bearings are normally supplied in 10 series, from 1/10″ to 5/16″ o.d., of high carbon chrome bearing steel. Most are supplied in stainless steel, some in beryllium copper, and all are assembled with best quality balls.

The wealth of engineering knowledge gained through participation in more than a million applications is available. Call on us for assistance, also request new catalog 53 and supplementary data sheets PE6.



Because of recent plant expansion, our facilities permit us to schedule prompt delivery of most sizes. We would welcome the opportunity to quote on your specific requirements.

Miniature *precision* Bearings

Incorporated Keene, New Hampshire

"Pioneer Precisionists to the World's foremost Instrument Manufacturers"

save
space
weight
friction

X-ray diffraction equipment in the Mallory Contact Engineering Laboratory. It is so sensitive it will identify contaminating films of less than a hundredth of a micron.

Less Than a Hundredth of a Micron!

The slightest trace of contaminating films on contact surfaces can be identified by X-ray diffraction equipment.

In a contact, trouble can be a lot of things. The paper used in packaging, the type of glue on sealing tape, insulation on a wire, atmospheric conditions . . . are just a few of the many things that can deposit a contaminating film on contact surfaces.

Because we have the equipment to identify contaminating films, we can track trouble to the source and correct it. This same X-ray diffraction equipment is also used in the development of new contact materials, by identifying unforeseen formations that may develop during production processes. It is used in life test work to study gradual changes taking place.

This is but one example of the complete facilities that are ready to go to work on your contact problems . . . whether it is a simple button contact or complex contact assembly that is involved. If you would like to improve the contacts in your products or produce them at lower cost, get in touch with us at your first opportunity. Our engineers will be glad to talk to you . . . answer your questions.

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WHILE YOU HELP SAVE

COPPER AND BRASS

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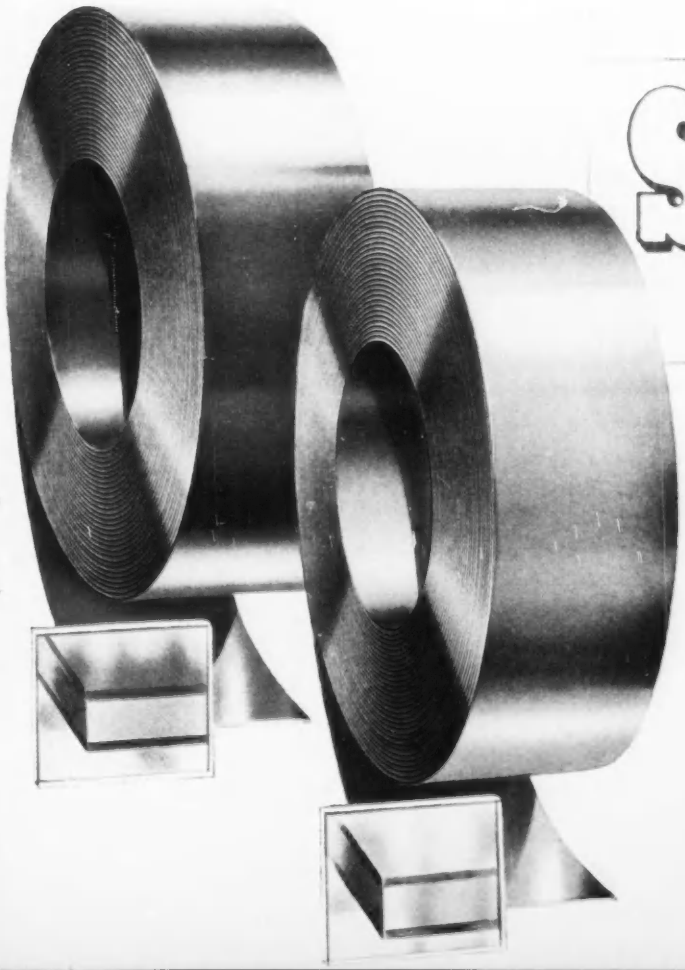

SuVeneer®

CLAD METALS

There's a two-way benefit in every coil of **SuVeneer** Clad Metals: profitable economy for you, and conservation of critical materials for defense.

The *solid* copper or brass on steel represents a saving of 70% to 80% over equivalent gauges of the single non-ferrous metals, and brings the inner strength of steel to your copper or brass product applications. The metals are bonded inseparably—you use your regular fabricating methods with this time-proved product. • Let us cooperate with you.

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CARNEGIE, PENNSYLVANIA

DIE CASTING—

for products that call for sturdiness plus elegance ...at moderate manufacturing costs

CASE HISTORIES FROM MT. VERNON FILES

You can appreciate the four outstanding characteristics of this Brumberger product within a minute of seeing it:

(1) attractive appearance

(2) luxurious feel

(3) sturdiness

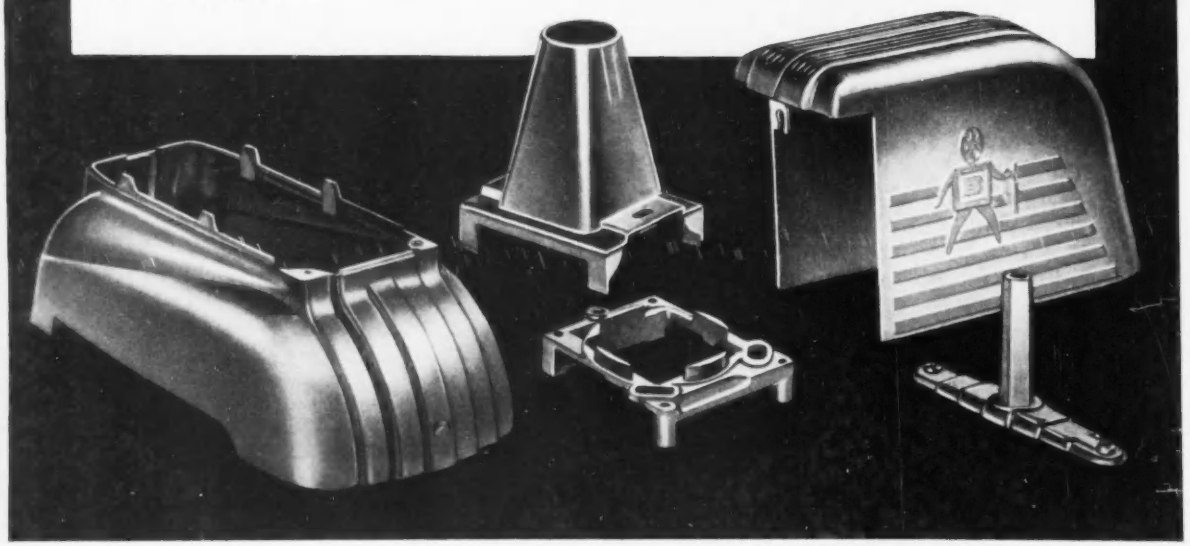
(4) extremely light weight

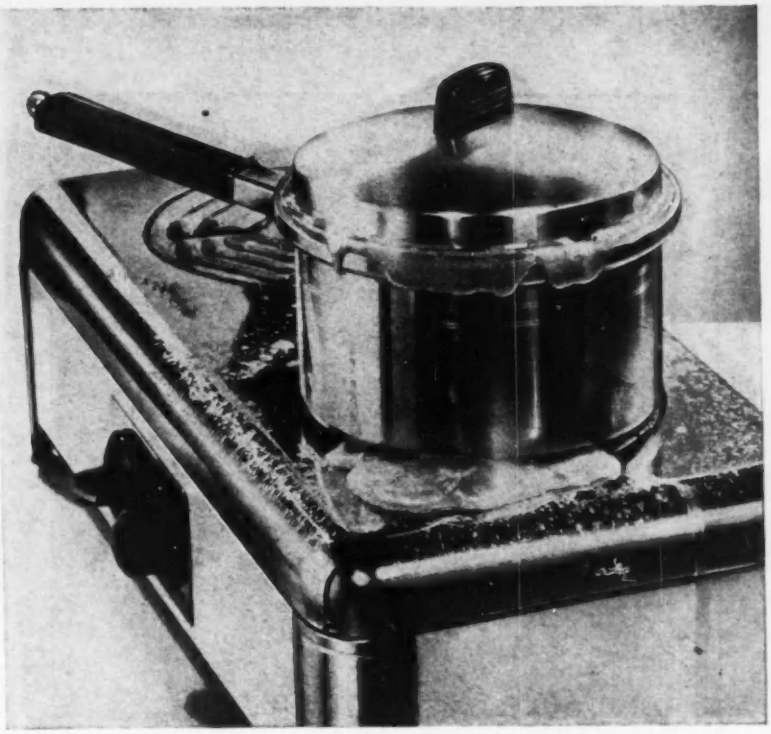
In time past, the Brumberger Company, of Brooklyn, N. Y., was accustomed to stamp all the parts of its photographic products from sheet steel, but today all units for the Deluxe Slide Projector are die cast.

Says Brumberger: "For an item such as our new 300-watt slide projector, which is styled to please the eye with gracefully curved surfaces and flowing lines, and engineered to give a lifetime of service, die casting is the supremely advantageous method of manufacture. Not only do we obtain a very good looking, lightweight, high-performance product, but the speed and economy inherent in the die casting process helps to hold down our manufacturing costs."

Perhaps you, too, have a product that requires to be both sturdy and elegant; or, perhaps the emphasis rests on only one of these attributes. However it may be, you'll profit by considering Mount Vernon die casting. Whether your specifications be simple or complex, we feel confident we can show you the way to economical output of quality merchandise.

MT. VERNON
DIE CASTING CORP.
MT. VERNON, NEW YORK





When pots boil over...

G-E glass-covered wire keeps appliances in service

When a pot boils over, the hot plate gets doused. Of course, this is just one of the many moisture conditions to which wiring in appliances, sterilizers, and small motors is subjected. But G-E glass-covered appliance lead wires are designed to withstand *both* moisture and heat, and give the long life and dependable service that your customers demand. In fact, whether your appliance wiring problem is extreme heat, moisture, corrosive vapor, or repeated bending—there's a G-E appliance wire designed for the job.

Choose the best appliance wires for your product from the complete G-E line of lead, stove, range, grounding, hinge, and permanent-wave machine wires. These G-E Deltabeston* wires and cables are unsurpassed in performance under severe operating conditions. For more information, write Section W90-667, Construction Materials Division, General Electric Company, Bridgeport 2, Connecticut.

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1878 75 1953 YEARS OF ELECTRICAL PROGRESS

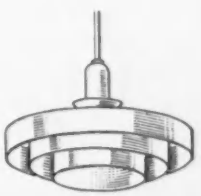
You can put your confidence in—

GENERAL ELECTRIC

WIRE AND CABLE IDEAS for Product Designers

Handy Reference Booklet: 24-page booklet for product designers contains charts, specifications, applications for the complete standard line of G-E wires, cables and cords. Write for your copy.

Machine Tool Wire: G-E Flamenol* machine tool wire meets J.I.C. Standards for machine tool control wiring. It is permanently color-coded for easy circuit tracing. Its small over-all diameter is ideal for limited spaces. Flamenol wire is not affected by lubricating or cutting oils, acids or alkalies.



Fixture Wires: G-E fixture wires are designed for sunlamps, therapeutic devices, and high-wattage units as well as lighting fixture interiors. Both high-temperature Deltabeston and oil-, acid-, moisture-, sunlight-, and flame-resistant Flamenol* wires are available.

Welding Leads: Designed for use either as electrode cables or work cables, G-E leads for arc welders are minutely stranded for maximum flexibility; covered with a smooth rubber jacket for toughness.

no chance for gas or liquid leaks

with SYLPHON SHAFT SEALS!

You can count on a Sylphon Seal to "leak-proof" a rotating shaft—seal it against seepage of gases or liquids. And do the job as you want it done. For Sylphon Seals are designed and engineered on order, exactly to *your* specific requirements.

Pictured here are typical examples of Sylphon Seals. They can be made to withstand pressures up to hundreds of pounds. They reduce friction—save power—minimize shaft wear.

Uses are many—hydraulic transmissions, refrigeration or air compressors, speed reducers, pumps, washing machines and other units. Size range is wide. Write for helpful engineering service. Ask for Catalog LP-825.

Examining surface of Sylphon Seals by means of optical flats, to make sure surfaces are flat and smooth.

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Temperature Controls • Bellows Devices • Bellows Assemblies

FULTON SYLPHON
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DC Aircraft Servo Motor
1/500 hp. Type RBDS-0810.
Dimensions 1 5/8" Dia., 2 5/8" over hubs.
Armature excited from 24 volt system.
Two fields controlled from tubes in push-pull.
Operates on 6 M.A. Differential field current.

Any electrical rotating equipment— we'll make it!

What the controls call for, a Holtzer-Cabot motor will do.

Whatever electrical rotating equipment you need, Holtzer-Cabot will design and build for you.

We've been building fractional and miniature motors for the best part of a century. Our present facilities for engineering in the realm of electrical rotating equipment, hydraulic and pneumatic controls, or mechanisms for servo-systems are at your service.

Send us your fhp motor and actuator problems. Size? We know how to make them small. Power? We make bantams to do the work of brutes. Dependability? Our experience in special motors dates back to 1875. Service? We have the capacity. So—let our engineers work on the projects *you* are working on. Why not call in our engineers to discuss the motor and actuator problems that are worrying you now?

HOLTZER-CABOT
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NATIONAL OIL SEAL LOGBOOK

Write our Redwood City office for reprints of this Logbook page

Sealing News & Tips

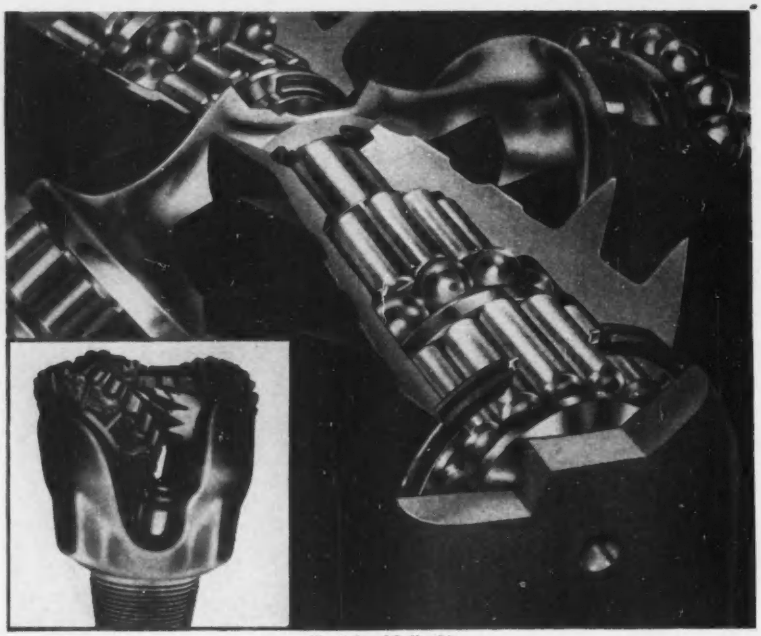

Fig. 1. Reed Roller Bit

National Syntech* Oil Seals lengthen life, improve performance of Reed roller bits

The conditions under which rotary rock bits operate are extremely severe. To lengthen bit life, improve performance and limit admission of abrasive materials from cutter bores, Reed Roller Bit Company utilizes National Oil Seals in their heavy-duty rock bits.

Three National seals—two standard design 360,000 series and one special design face seal—are installed in each bit. These seals are of springless design with precision-trimmed sealing lips of National Syntech synthetic rubber (Figure 2). The inherent "flex" action of the Syntech lip insures satisfactory sealing despite runout and the heavy impacts of rock drilling. The Reed Company reports that "Bits containing seals are in noticeably better condition than bits not containing seals—both being run under the same conditions and for the same length of time."

The National Oil Seals in this application illustrate but two of thousands of National designs. Perhaps your product can benefit by utilizing standard design National seals; perhaps special seals are required. In either case, our long experience with sealing problems is at your disposal.

Fig. 2. (L) 360,000 series Syntech (R) 6543 Syntech

*T. M. Reg.

National 350,000 series with flange case

To simplify installation, many users specify National Oil Seals with flanges. Illustration shows a standard design National 350,000 series Syntech* Oil Seal with bolt-on flange. This spring-tensioned design with synthetic rubber sealing lip is often specified in applications involving high speeds and high temperatures.

National 50,000 series, modified

A standard design National seal, modified, with special flange. O.D. of flange press fits into housing. National 50,000 series leather seals such as this (with and without flange) are ideal for heavy-duty applications where seals may run semi-starved and external dirt or dust conditions are severe.

National O-Ring Catalog

National, a world leader in oil seals, now offers a complete line of standard size commercial grade O-Rings. See the nearest National Applications Engineer for complete details or write direct for new National O-Ring catalog.

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If you make any parts like these....

Piston Pins	Jacks
Pump Cylinders	Gun Barrel Drills
Axles (front and rear)	Axle Housings
Bearing (Races)	Propeller Shafts
Airbrake Parts	Bobbins
Drag Links	Push Rods
Table Rollers	Rocker-Arm Shafts
Exhaust Lines	Hollow Spindles
Drill Shanks	Shock-Absorber Casings
Frame Spacers	Spring Bushings
Grease Guns	Ironer Rolls
Armature Bodies	Tie Rods
Hydraulic Brake Lines	Drill Collars
Filler Tubes	Torque Tubes
Hydraulic Hoist Cylinders	Spool Holders
Ignition Wire Tubes	Golf Shafts
Radio Parts	Transmission Parts
Bushings	Spindle Caps

you can make them

better, faster and at less cost

with SHELBY SEAMLESS STEEL TUBING

BECAUSE Shelby Seamless comes to you with the basic shape and hole already made you can eliminate or greatly reduce many time and labor-consuming operations connected with boring and machining. You also save the wear and tear on expensive tools, as well as the needless waste of steel.

Another important advantage in using Shelby Seamless Tubing is that its excellent machining characteristics and uniformity speed up production and improve the quality of your output. *You can turn out parts by the millions and the last part will be as metallurgically and dimensionally accurate as the first part produced.*

Shelby Seamless Steel Tubing is available in a complete range of sizes; in different wall thicknesses; various finishes and steel analyses. Our engineers will be glad to submit recommendations based on a study of your particular requirements.

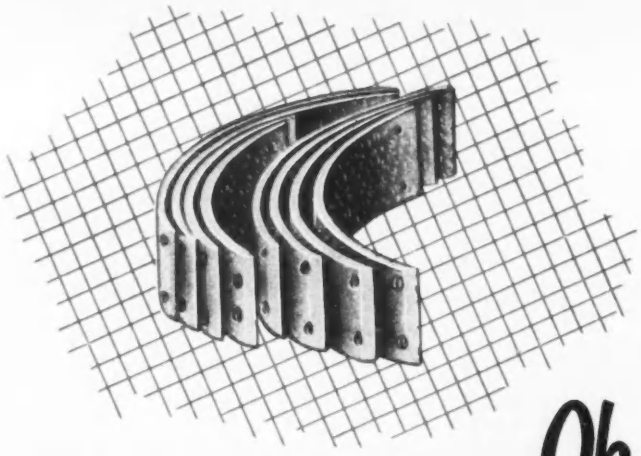
All Shelby Seamless Tubing is pierced from solid billets of uniform steel. This is the one manufacturing method that assures absolute uniform wall strength.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S SHELBY SEAMLESS MECHANICAL TUBING

USS

UNITED STATES STEEL



BETTER WIRE—BETTER BRAKE LINING? Oh, YES!

for Automobiles . . . Trucks . . . Motorcycles

Farm Implements . . . Hoists . . . Tractors

Earth Moving and other Industrial Machinery

REYNOLDS WIRE protects performance

Who makes the brake lining? The answer is important to automotive, agricultural and other industrial users.

But who makes the wire cloth that reinforces the brake lining?

That, too, is important. To the makers of the brake lining. To those who build brake lining into their motor cars, trucks, buses, farm implements, construction and other kinds of machinery. And to the users of those machines.

Because the better the wire, the more dependable and the more uniformly effective the braking. And it prolongs the wear and adds to the service life of the lining.

There is no better reinforcing agent than Reynolds Wire Cloth—for all compounds, plastics, rubbers, and building materials.

For the automotive and all other "precise specification" industries, Reynolds is made to meet special requirements—by engineers with 50 years' specialized know-how, using the most modern equipment and methods. Consultation without obligation.

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO.
DIXON, ILLINOIS

Divisions of National-Standard Co.

ATHERIA STEEL...*Clifton, N. J.*.....Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.*.....Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY...*Jersey City, N. J.*.....Metal Decorating Equipment
WORCESTER WIRE WORKS...*Worcester, Mass.*....Round and Shaped Steel Wire, Small Sizes

NS NATIONAL-STANDARD Company NILES, MICHIGAN

RESEARCH KEEPS **B.F.Goodrich** FIRST IN RUBBER

New sealing zipper zips to seal out gas, liquids, dirt . . . unzips to let you in

HERE'S A NEW KIND OF SEAL that shuts out liquids, gas, dirt—yet zips open in seconds. It's the B. F. Goodrich Sealing Zipper.

It is made with molded rubber lips that overlap with such precision that they seal *tight*, even without pressure. Under pressure, the seal actually tightens. The only limit on the pressure, in fact, is the structural strength of the zipper itself!

This seal is so flexible, it goes around curves and odd shapes where clamps won't work. Repairs are faster because zipper halves are interchangeable. It can be made of compounds to resist weather, oils, gasoline, chemicals. It can be sewn or cemented to metal, wood, glass. The rubber can be made to match any color.

In the picture, the B. F. Goodrich Sealing Zipper fastens the rear window of a convertible auto to the fabric top. It offers the first *complete* protection to keep weather stains and mildew from the inside fabric. It gives neater, tailored styling. Color matches, inside and out. And it cuts production costs, because it is so easy to install. It is now standard on three makes of convertibles.

The BFG Sealing Zipper is ideal for any use that combines a need for an airtight, watertight barrier with ease of opening. It has been proved in dozens of applications for aviation and transportation fields. Write Dept. A-13 for complete information, or send coupon below. The B. F. Goodrich Company, Zipper Division, Akron, Ohio.

B.F.Goodrich
Airtight, Watertight Sealing Zipper

SEND NOW FOR FREE FOLDER
Gives case histories, design advantages, suggested uses.

The B. F. Goodrich Company
Dept. A33, Akron 18, Ohio

Name _____

Company _____ Title _____

Address _____

City _____ Zone ____ State _____

Get on the right track to

BEAT WEAR

Nordberg Mfg. Co.
Milwaukee, Wisconsin

The Product: Nordberg Hydraulic Power Jack used to lift rails and ties from roadbed during reballasting or resurfacing.

The Problem: To keep wear in the moving parts of the hydraulic rams to a minimum. Because the piston and gland act as guides, close tolerances must be maintained. In addition, the hydraulic ram utilizes pressures of 3000 psi and, although the piston has "O" rings with back-up washers, extremely close fits must be maintained between piston and gland to hold this pressure.

The Solution: AMPCO METAL for both piston and gland.

The Results: Thanks to the ability of Ampco Metal to resist wear, proper clearances and tolerances are maintained. The result — dependable performance, greater output.

IT'S PRODUCTION-WISE TO AMPCO-IZE

Nordberg Track Jack in operation. Machine consists basically of two hydraulic rams, each capable of lifting 24,000 lbs. Ampco Metal is used in the moving parts of the hydraulic rams because of its excellent resistance to wear.

.use AMPCO* METAL

One of the easiest ways to beat wear is to use Ampco Metal. That's why more and more designers and plant-operating men turn to these versatile aluminum bronze alloys. They know that Ampco Metal builds extra toughness and stamina into their machines — toughness and stamina that mean longer service life, more dependable performance, lower costs.

And unusual resistance to wear isn't the whole story. Ampco Metal has high compressive strength — doesn't squash out. It resists abrasion, erosion, corrosion. It has high impact and fatigue values, and excellent bearing qualities.

You can get Ampco Metal in practically any form you need — sand and centrifugal castings, sheet, plate, forgings, bars, tubes, welding wire and electrodes.

Beat wear! Use Ampco Metal in both your product and plant — for that all-important extra margin of safety and dependability. For the complete story, contact your nearest Ampco field engineer or send the coupon.

Tear out this coupon and mail today!

*Reg. U. S. Pat. Off.

Gear for metal spray gun — Extruded-rod.

Flywheel — Centrifugally-cast.

Blade bushing for airplane propeller — Centrifugally-cast.

Be Cu

Beryllium Copper is now available, both cast and extruded. Your inquiries invited.

Ampco Metal, Inc.

MILWAUKEE 46, WISCONSIN

West Coast Plant
BURBANK, CALIFORNIA

AMPCO® metle

LET AMPCO PROVE ITS METAL

AMPCO METAL, INC., Dept. PE-6, Milwaukee 46, Wisconsin

I'm interested. Send me your free Ampco Metal literature giving descriptions and general applications of Ampco Metal.

Name..... Title.....

Company.....

Company Address.....

City.....( ) State.....

9-12

PROBLEM:

To get a Thermostat Element with the stability to operate for 100 years without calibration

SOLUTION:

General Plate TRUFLEX® Thermostat Metal provided this stability

The Museum of Science and Industry laid its "living" cornerstone September 3, 1952, thus starting a one hundred year experiment.

Within the 1-ton limestone block is a specially fabricated monel box containing a score of physically or biologically "alive" items from bacteria to metals . . . including a thermostatic clock which will record the years.

This clock is constructed to register once as the temperature falls to 20°F and will not count again until the temperature has risen to 85° and again fallen to 20°. It will register once each winter and count the number of years that have passed since the laying of the cornerstone.

Essential to the reliability of the clock was a thermostat element which would keep its stability without further calibration for 100 years.

The scientist concerned with the project presented the problem to General Plate whose engineers provided the solution with a specially designed Truflex thermostat metal element.

You, too, can obtain constant and accurate performance in your products because General Plate fabricates to your exact specifications, complete Truflex thermostat metal units ready for installation. You get reliable performance because every order comes to you an exact duplicate of the original . . . consistently uniform in tolerances, temperature reaction and performance, thus preventing rejects and costly adjustments in assembly.

General Plate TRUFLEX thermostat metal assemblies are made to meet your specific requirements for temperature range, electrical resistance, corrosion resistance, etc. If you prefer to make your own assemblies, General Plate will produce Truflex thermostat metal sheet or strip to your material specifications. Write for information or engineering assistance.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
16 FOREST STREET, ATTLEBORO, MASS.

Now— ALUMINUM SOLDERING MADE EASY!

A Universal Flux For All Commercial Metals Usually Joined By Soldering

S-X WIRE PRODUCTS

Aluma-Flux SOLDERING FLUX

Manufactured By
ESSEX WIRE CORP.
Ft. Wayne, Ind.

Here at last is the only flux ever developed that makes possible the *non-corrosive* joining of all types of aluminum alloys by any soldering method—manual, dip or mechanical. No cleaning is required after soldering is accomplished—Aluma-Flux leaves no corrosive residue—soldered pieces are ready for use immediately.

S-X Aluma-Flux is equally effective for soldering stainless steel, bare and galvanized carbon steel, cast iron and other ferrous alloys, copper, brass and nickel—all commerical metals commonly joined by soldering. The joining of aluminum to brass; the coating of copper with tin; and the soldering of other unlike metals is made fast and easy with Aluma-Flux.

Soldered joints in aluminum produce no corrosive action due to flux residue when exposed to salt-spray, high humidity, alkaline water, etc. Aluma-Flux shows no detrimental effect on any soldered joint.

S-X Aluma-Flux can be used with 100% satisfactory results in powdered form as delivered, or in molten form—whichever is most efficient for the job. Virtually any type of solder can be used. Aluma-Flux can be stored indefinitely without change of weight, or any impairment of fluxing efficiency. Being non-hygroscopic, it will not absorb water.

In addition to its exceptional fluxing characteristics, Aluma-Flux offers many other cost-reducing, time-saving advantages . . .

The success of S-X Aluma-Flux in the soldering of aluminum is due to the action in which the flux initially reduces surface oxides and then immediately deposits a thin layer of plating material on the solder area. Oxidation of the area to be soldered is thus prevented while the plating material serves as an approved base on which to solder. In addition to its soldering efficiency, Aluma-Flux reacts completely during the joining operation so there are no corrosive flux residues to lower corrosion resistance of the finished joint.

ALUMA-FLUX IS READY FOR IMMEDIATE SHIPMENT IN CONVENIENT SIZE METAL CONTAINERS.

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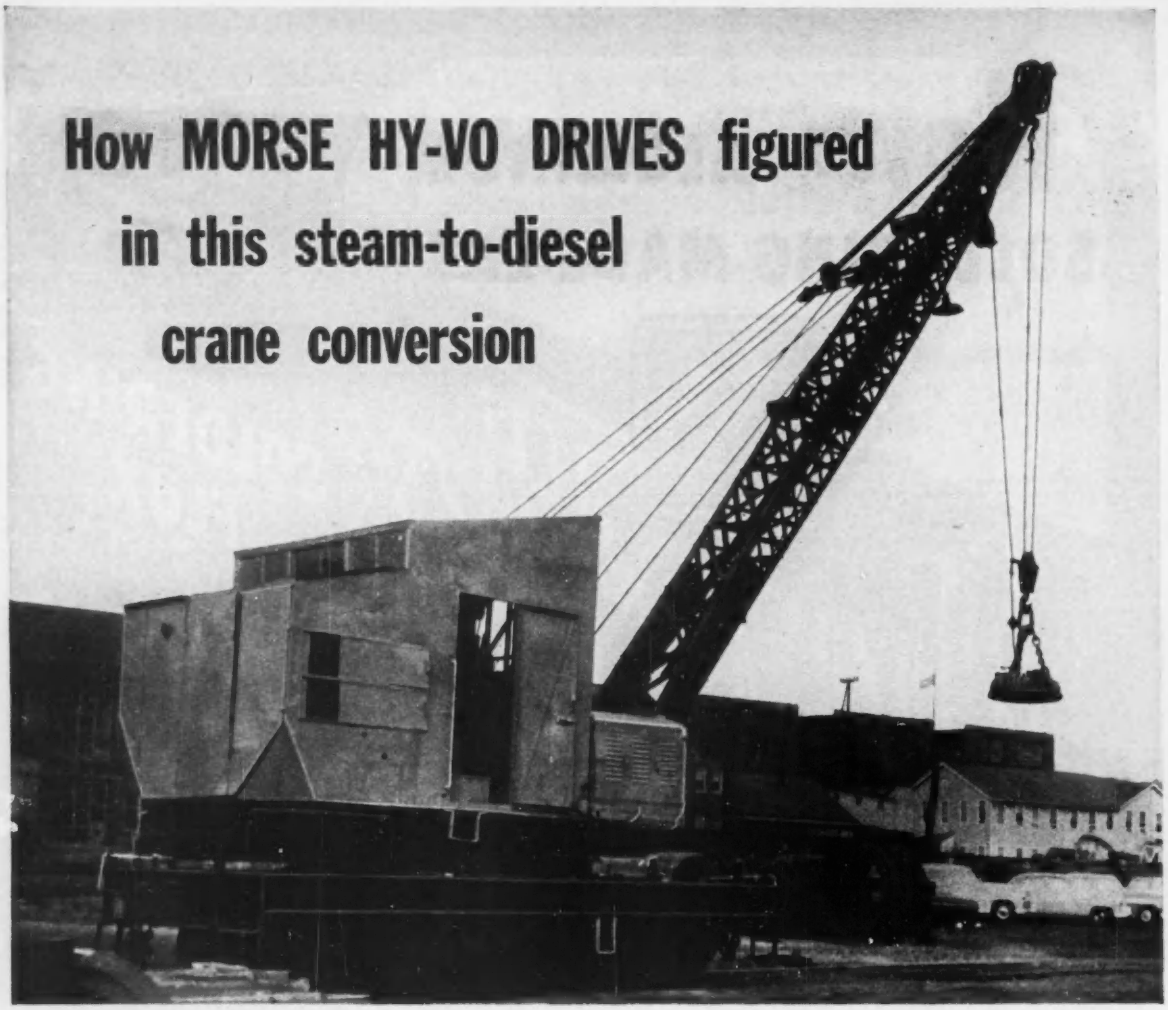
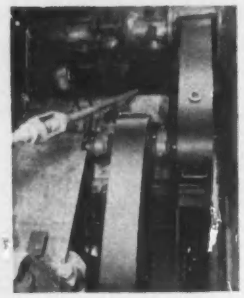
How MORSE HY-VO DRIVES figured in this steam-to-diesel crane conversion





Inset shows encased Morse Hy-Vo Drives. Note narrowness of drives in relation to 165 hp. power-transmission requirements.

After thirty-four years as a steamer, this Browning locomotive crane owned by Edgewater Steel Company was converted to diesel power.

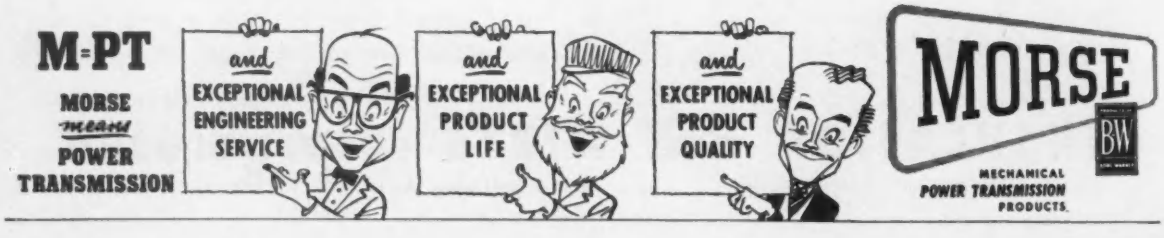
Its new power equipment: A Cummings 165 hp. engine with a torque converter drives a 1″ x 4″ Morse Hy-Vo Drive, connecting converter output shaft to jackshaft, second reduction is made with a 1″ x 5″ Morse Hy-Vo Drive.

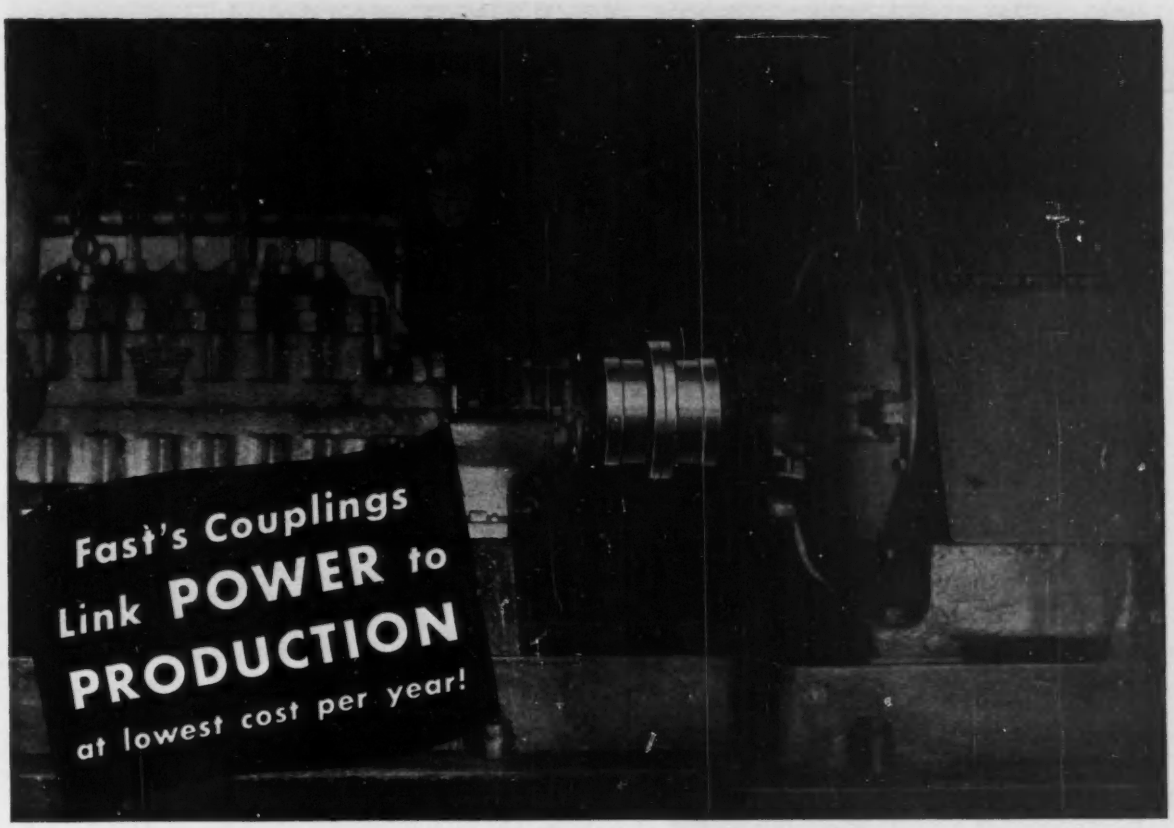
Results: Smoother, more positive control, more reserve power. Operating cost per year cut from $11,232.00 to $7,887.36, a savings of $3,344.64.

Morse Hy-Vo is especially suited to steady or intermittent transmission of heavy loads in cramped space.

In fact, Hy-Vo can transmit up to 5000 hp., run at linear velocities of 6500 fpm. and speeds of 3600 rpm. At the same time, it gives up to one-third longer service life, reduces operating and maintenance costs as much as 50%; runs coolly, quietly, smoothly with less than 1% friction loss. In most instances, it does away with bulky outboard bearings.

With just these few facts in mind, *think* of the advantages in design and function opened to you by Morse Hy-Vo Drive. Write us for details on Hy-Vo in your applications, or let us send you Hy-Vo Catalog C72-51. Morse Chain Company, Dept. 586, 7601 Central Avenue, Detroit 10, Michigan.





Over half a million FAST'S Couplings now in use!

THROUGHOUT industry, Fast's are rated the most dependable couplings on the market... to the tune of over half a million now in service! Year in, year out, they continue to *outlast the equipment they connect* . . . save time, maintenance and money by eliminating costly coupling failures.

Actual cases on record show many Fast's Couplings have been in operation for 25 and 30 years without trouble. And every major producer of high-speed equipment now uses Fast's!

Solve your coupling worries! Write today for full details on Fast's Couplings and Koppers Engineering Service to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 236 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*
236 Scott St., Baltimore 3, Md.

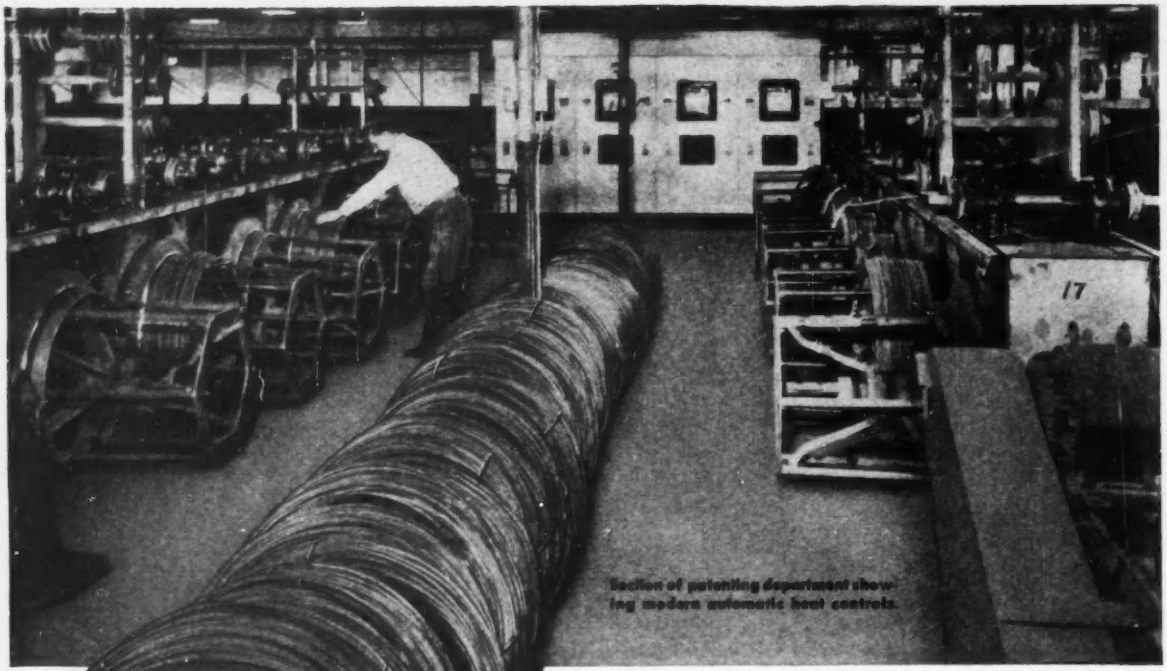
Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name_____

Company_____

Address_____

City_____ Zone____ State_____



Section of patenting department showing modern automatic heat controls.

wire control *to save you money!*

● The accuracy with which your wire specifications are met, *and held,* quite naturally has an important bearing on the cost, speed and quality of your production. That's why you can profit by National-Standard's facilities and exceptional experience in producing fine wire of many metals and alloys for exacting needs.

Here, all phases of wire processing . . . drawing, cleaning, heat treating, plating, finishing . . . are controlled to a degree and accuracy never exceeded, not often equalled. It's a firmly rooted National-Standard policy that can save you time and money.

Remember, too, another National-Standard policy that can work to your advantage—highly qualified engineering service in the development and application of special wire to solve special problems. As always, it's yours for the asking.

NS NATIONAL-STANDARD Company NILES, MICHIGAN

DIVISIONS OF NATIONAL-STANDARD CO.

ATHENIA STEEL	*Clifton, N. J.*	**Flat, High Carbon, Cold Rolled Spring Steel**
NATIONAL-STANDARD	*Niles, Mich.*	**Tire Wire, Stainless, Fabricated Braids and Tape**
REYNOLDS WIRE	*Dixon, Illinois*	**Industrial Wire Cloth**
WAGNER LITHO MACHINERY	*Jersey City, N. J.*	**Metal Decorating Equipment**
WORCESTER WIRE WORKS	*Worcester, Mass.*	**Round and Shaped Steel Wire, Small Sizes**

There's a *simple* way to solve what appears to be a complex speed reduction problem

Get the proper drive combination that best meets your requirements from the broad LINK-BELT line

YOU'LL find your power transmission costs are lowered several ways when you use Link-Belt enclosed gear drives. First, Link-Belt offers a broad range of types and sizes in helical, herringbone and worm gear designs. You get the *one* reducer best suited to your needs.

In addition, Link-Belt builds a complete line of power transmission machinery. Installation and alignment are simplified because dimensions of Link-Belt chains and sprockets, bearings and couplings are all coordinated. And there's no need to call in another firm for any information or assistance.

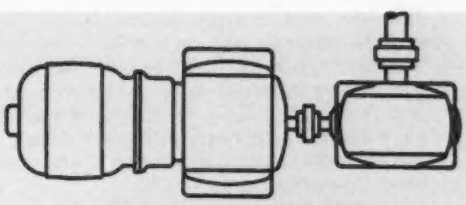
This overall integration—plus the long life built into every piece of Link-Belt equipment—guarantees optimum efficiency. Result: lower power consumption and maintenance costs.

Make the nearby Link-Belt sales office your power transmission headquarters. Nowhere else can you get the great selectivity that assures you of the best in enclosed gear drive applications.

LINK-BELT

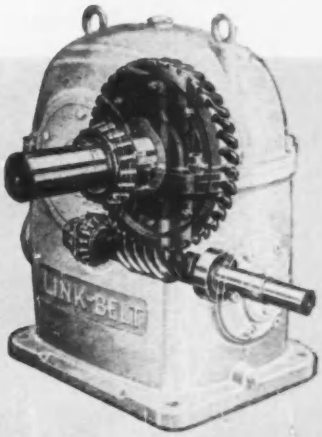
ENCLOSED GEAR DRIVES 13,127-A

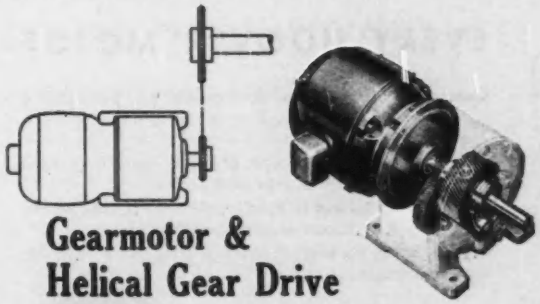
LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities.



Worm Gear Drive

WORM GEAR and P.I.V. variable speed drives are shown direct-coupled. Link-Belt worm gear drives are available in 3.1:1 to 8000:1 reduction ratios—1400 to 123,000 in. lbs. torque—0.22 to 564 output shaft rpm. Ask for Book 2324A.





Gearmotor & Helical Gear Drive

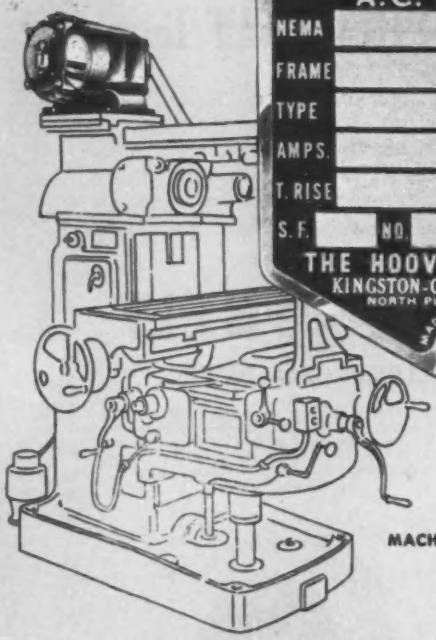
GEARMOTOR is shown with roller chain drive. Link-Belt Helical Gear Drives, Gearmotors and Motogears are available in 6.2:1 to 292:1 reduction ratios—1 to 30 hp—6 to 280 output shaft rpm. Ask for Books 2247 and 2451.

Herringbone Gear Drive

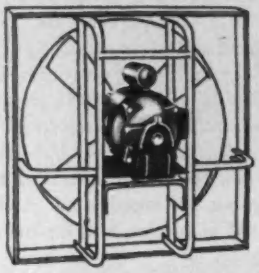
HERRINGBONE GEAR DRIVE is shown connected by flexible coupling to motor and with roller chain takeoff. Link-Belt Herringbone Gear Drives are available in 2.84:1 to 326:1 ratios—0.4 to 2480 hp—2.2 to 623 output shaft rpm. Ask for Book 2519.

Here's the nameplate . . .

Write your own specifications!



MACHINE TOOLS

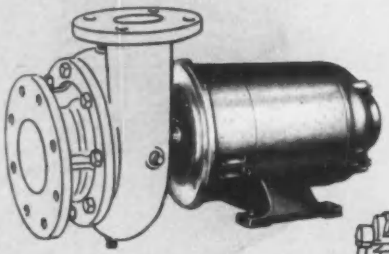


AIR-MOVING EQUIPMENT

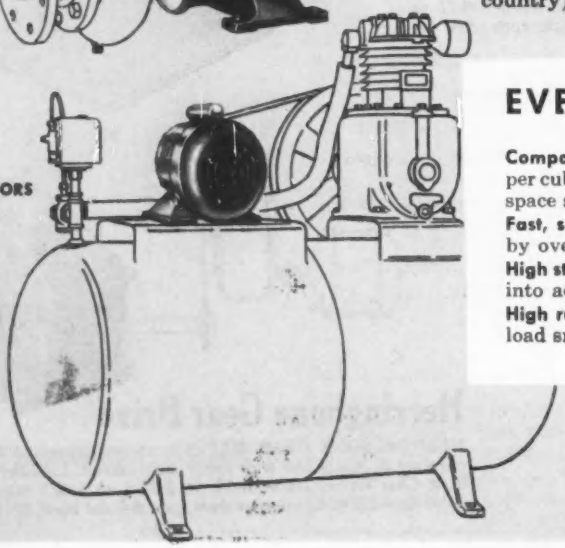
No component part of the equipment you manufacture must meet more exacting requirements than the power plant. And however exacting those requirements are, there's a Hoover Motor that will more than meet them.

You will find in the current Hoover catalog complete descriptions of a wide range of in-production types, built for reliable performance under almost every condition of service. And on new or special applications a Hoover engineer is always available to work with your design engineers on motor specifications that are "custom tailored" to your needs.

For further information call your Hoover representative (there's a Hoover Motor Sales Office in or near every major fabricating center in the country) or use the coupon on the opposite page.



PUMPS



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EVERY HOOVER MOTOR

Compact Design: More horsepower per pound and per cubic inch of space. They're freight cost savers, space savers.

Fast, sure starts. Reliable starting switch proved by over 2,000,000 starts and stops.

High starting torque to spin hard-to-start machinery into action without strain or vibration.

High running torque to carry a steady or varying load smoothly.

HOOVER

HOOVER

Heavy-Duty Electric Motors

for every power need

up to 5 h.p.

OFFERS THESE ADVANTAGES

Big overload capacity. Service factor reserve 15% to 25%.

Cool running, quiet running designed to be fully self-cooled as they run—no drag or friction.

More economical in initial cost, operating cost and maintenance. Built for a long, long life of trouble-free operation.

Quick service when and where you need it. Hoover's service facilities are world-wide— always ready to help guard your good name.

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Week in and week out, Hoover is producing a very substantial volume of essential materials for the Armed Forces.

THE HOOVER COMPANY
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PLEASE SEND ME further information on Hoover motors.

I am particularly interested in motors for_____

_____(indicate type of equipment).

Name_____

Company_____

Address_____

City_____ Zone____ State_____

put 43 years of experience to work for you...

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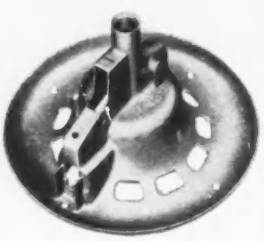
Most Modern Die Casting Equipment

Complete Machining, Polishing and Assembly Facilities



Few have served longer

. . . none have served better.

Stewart DIE CASTING

A DIVISION OF... STEWART SW WARNER

CHICAGO, ILL., 4535 FULLERTON AVE....BRIDGEPORT, CONN., 275 WARREN ST.

"We expect 20 years of service or *more* from these American Quality Springs"

...says SIMMONS COMPANY, World's largest producer of sleeping equipment

EVERY housewife in America knows that the name *Simmons* is an ironclad guarantee of quality when it appears on a mattress or sofa.

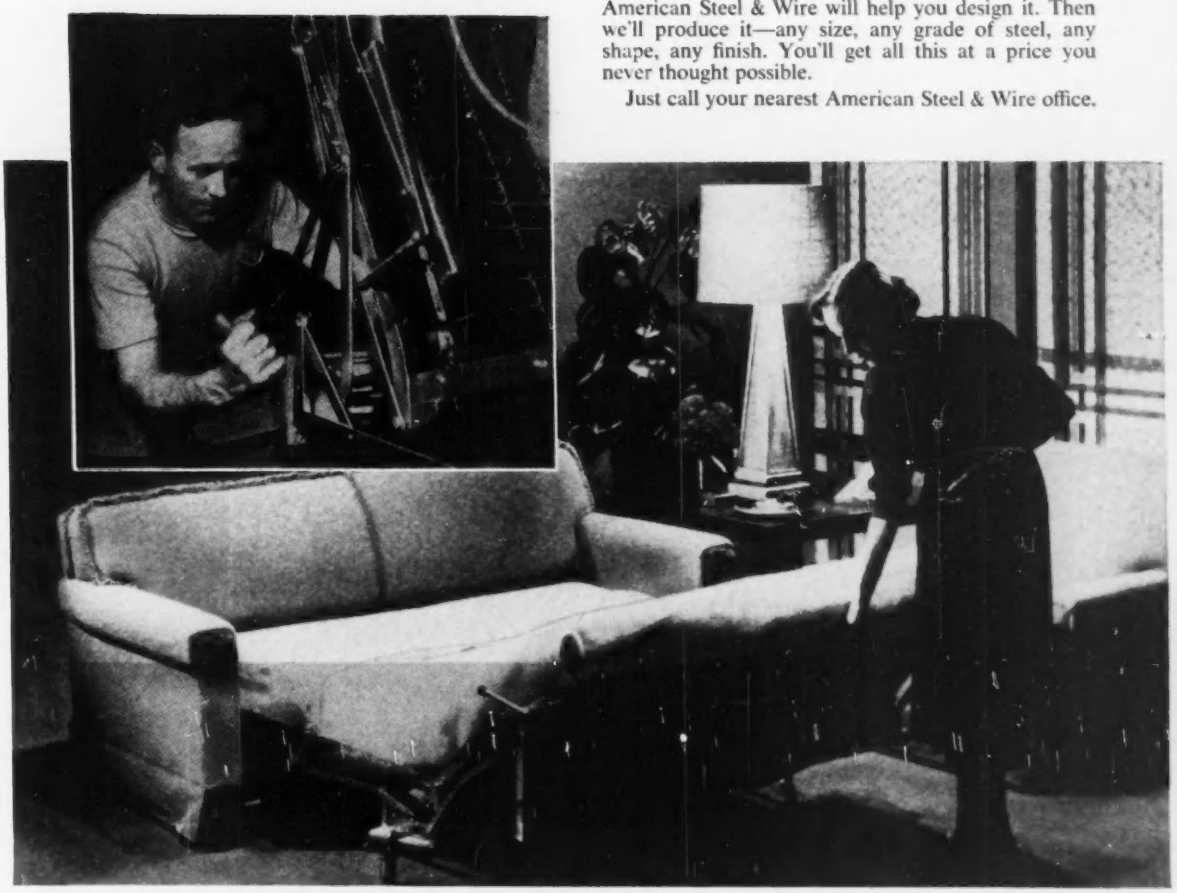
If you visited any of the 7 Simmons factories, you'd know why. Simmons has built an unparalleled reputation by *insisting* on fine workmanship and highest quality component parts.

Look at the famous Hide-A-Bed shown here. You don't have to yank and pull to open it into a comfortable bed. It glides open easily on 6 counter-balance American Quality Springs. Each of these 9-inch springs must withstand a stretch to 15 inches. In a 20-year period, these 6 helical springs are stretched to the limit 14,600 times.

We produce these springs for Simmons using a high-grade oil-tempered wire. As a result, the finished springs meet very close load tolerances, and they are consistently straight.

If you need a typewriter spring, an automobile axle spring, or a spring to support a giant locomotive, American Steel & Wire will help you design it. Then we'll produce it—any size, any grade of steel, any shape, any finish. You'll get all this at a price you never thought possible.

Just call your nearest American Steel & Wire office.



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USS

U·S·S American Quality Springs

UNITED STATES STEEL

...do you have a *motor mounting problem?*

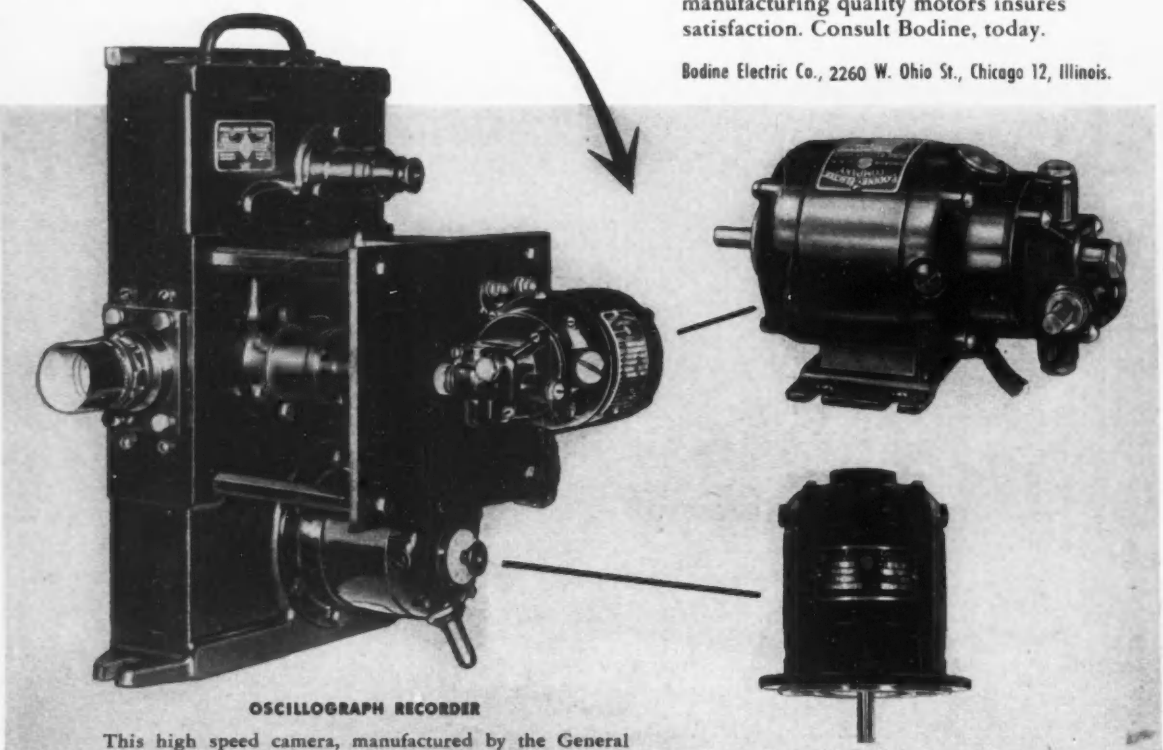
Bodine has a broad line of dependable motors and mounting arrangements to solve this problem for you

Bodine fractional horsepower motors can be engineered to your products, too. Over 3500 standard motors, in all types and fractional horsepower ratings, from 1/2000 to 1/6, are available. Precise, trouble-free operation of Bodine motors, over long periods of time, has made them a requirement for many quality products. Nearly a half-century's experience in designing and manufacturing quality motors insures satisfaction. Consult Bodine, today.

Bodine Electric Co., 2260 W. Ohio St., Chicago 12, Illinois.

GENERAL RADIO COMPANY

Solved it this way



OSCILLOGRAPH RECORDER

This high speed camera, manufactured by the General Radio Company, is suitable for recording the trace of a cathode-ray oscillograph to obtain an accurate record of transient phenomena.

"Bodine's extensive line . . . high quality . . . and practically no service troubles formed the basis of our selection," stated the General Radio Company, users of Bodine motors for the past 16 years.

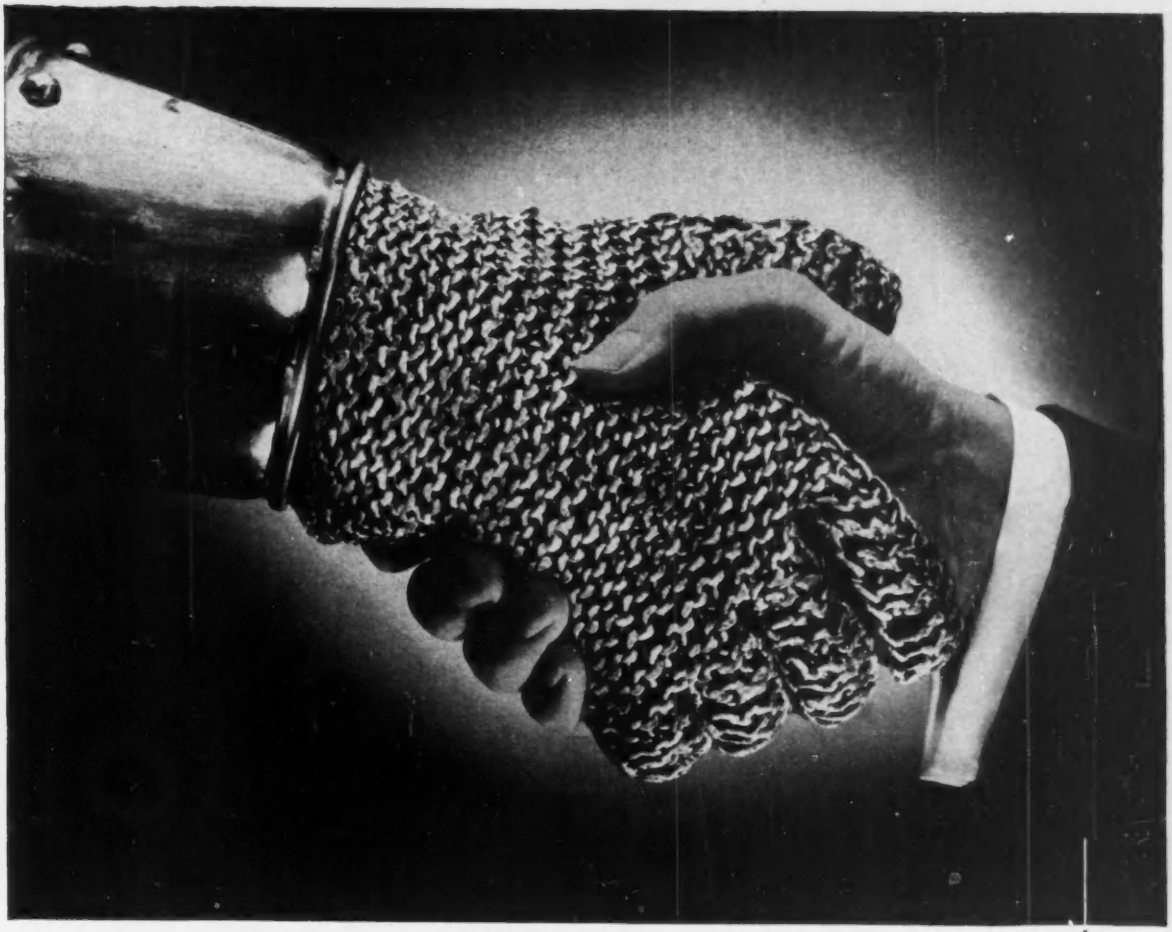
Numerous Mountings Available

THE POWER BEHIND THE LEADING PRODUCTS

Bodine

FRACTIONAL HORSEPOWER *Motors*

BODINE



RIVERSIDE ALLOYS ARE INDUSTRY'S ALLIES

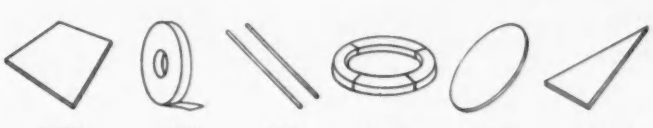
Stemming from the precision-requirements of watchmaking, Riverside Alloys have come to encompass every industry using non-ferrous metals within the last century.

Quality and uniformity are musts. Riverside Alloys come in sheet, strip, rod, wire, circles, blanks . . . in phosphor bronze, nickel silver, cupro nickel and beryllium copper.

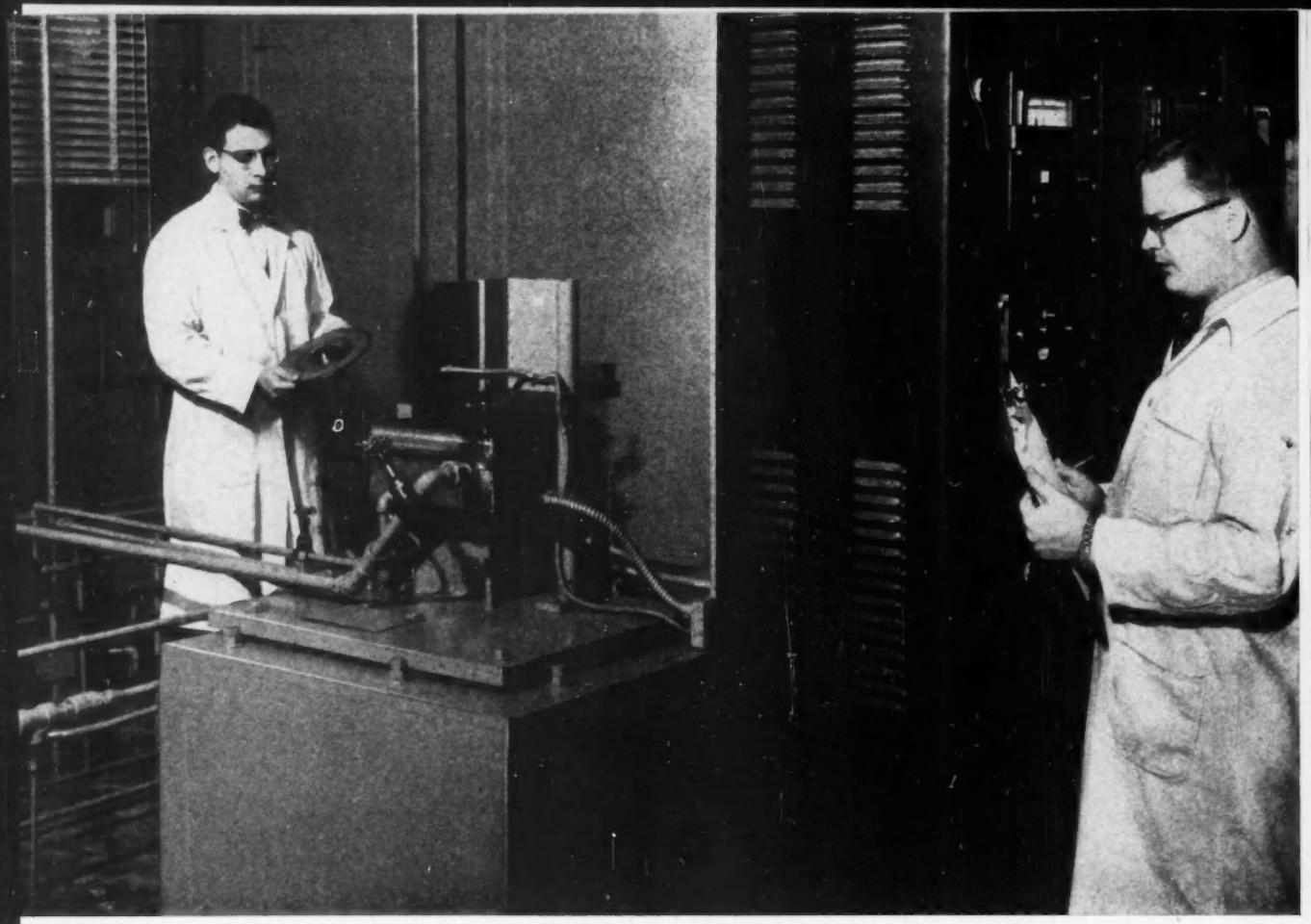
Tell our metallurgists your problems and watch them go to work. In the meantime, write for the Riverside Handbook. Yes, Riverside *Alloys* are Industry's *Allies*. The Riverside Metal Company, Riverside, N. J. Branches in principal cities.

RIVERSIDE
ALLOYS

PHOSPHOR BRONZE • NICKEL SILVER
CUPRO NICKEL • BERYLLIUM COPPER



Free pocket-size Alloy Handbook. Your reference and guide to Alloy specifications. Write today.



These men can help you find the right clutch facing...*faster*

Whether you're looking for facing materials to suit a new wet clutch design—or to improve the performance of an existing unit—the Armstrong men and equipment shown here are ready to save you time and trouble.

These men compound Armstrong's Friction Materials. They make your job easier by making it unnecessary for you to field test a random variety of possible facings.

It would be good, of course, if it were possible to look at a new clutch design and immediately select a facing with precisely the characteristics needed. Unfortunately, however, even minor design differences can create new and unpredictable facing problems.

Your first step, then, is to install a few likely Armstrong materials in experimental clutch units. These materials will be suggested by Armstrong on an "educated guess" basis after studying your design and your torque and engagement specifications. Since this guess is based on many years of compounding experience, these first materials probably will be very close to what you want.

Nevertheless, once you have accumulated performance data on the suggested facings, Armstrong compounders compare your results with their laboratory data on these same materials. This comparison tells them what formulation modifications, if any, may be needed to meet your performance requirements.

These requirements can be correlated closely with material formulations because Armstrong's compounders know what performance differences result from widely varied changes in formulation or manufacturing method. They collect these data on a regular, orderly basis using the equipment shown above.

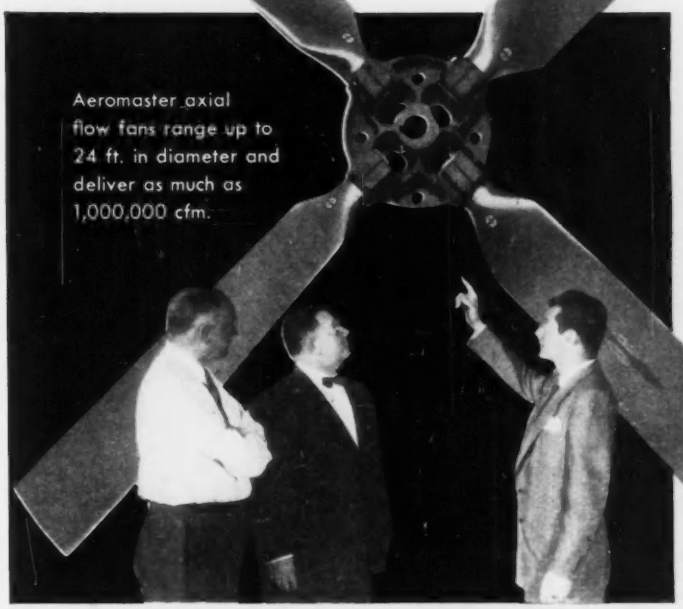
In their studies, hundreds of different materials are operated on this Armstrong-built test unit. The behavior of each material is plotted under standard, controlled conditions. This gives Armstrong's compounders a large library of data upon which to draw. That's why they usually can help you quickly with facing problems involving anything from a conventional wet clutch to the newest dream design.

Whatever your current facing problem may be, send us details about it. We'll be glad to call and go over your questions with you or, if you prefer, we'll suggest suitable materials for test. Write Armstrong Cork Company, Industrial Division, 7206 Irvin Street, Lancaster, Pennsylvania. Available for export.

ARMSTRONG'S FRICTION MATERIALS

DUCTALLOY® CASTINGS GIVE KOPPERS FANS

Strong, Sound Hubs



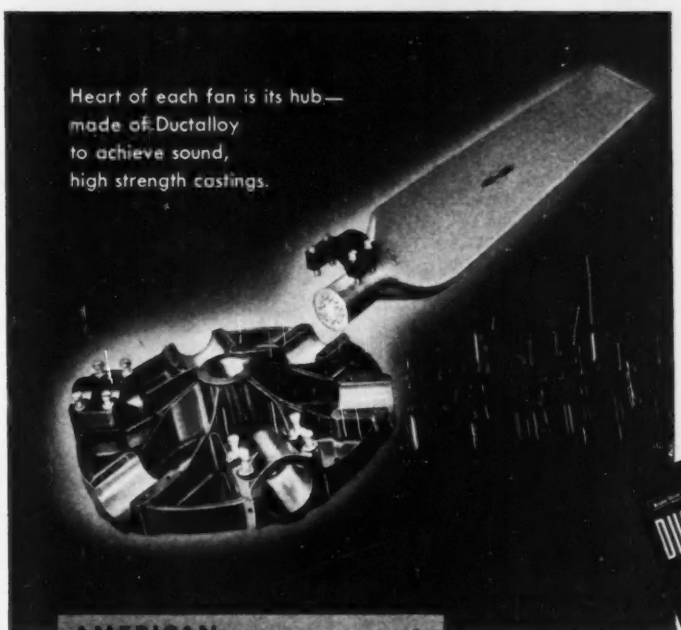
Aeromaster axial flow fans range up to 24 ft. in diameter and deliver as much as 1,000,000 cfm.

EASILY CAST, EASILY MACHINED

High performance fans made by the Aeromaster Fan Department of Koppers Company, used in cooling towers near diesel engines and compressors, must withstand considerable applied vibration in addition to normal operating loads. For this reason cast steel was originally specified to provide the necessary hub strength; but machining costs were excessive, surfaces were poor, and too many castings were "lost" when machining revealed hidden defects. A switch to malleable iron only aggravated the problem of casting soundness. The answer was Ductalloy 60—Brake Shoe's easily machined high strength ductile cast iron.

MACHINE SHOP REJECTS ENDED

Ductalloy 60 is a ferritic iron having 60,000 psi minimum tensile strength, 40,000 psi minimum yield strength and 10% minimum total elongation, all guaranteed. Use of this material has virtually eliminated the high scrap loss formerly encountered when defects were uncovered during machining of castings made in either steel or malleable iron.



Heart of each fan is its hub—made of Ductalloy to achieve sound, high strength castings.

your problem — Ductalloy may solve your problem if it involves economical production of complex metal shapes that are difficult to cast in steel, expensive to forge or lacking strength in gray iron. Brake Shoe's experience, research laboratory and experimental foundry are available to help you best utilize Ductalloy's unusual combination of characteristics. Write for this new technical bulletin today.

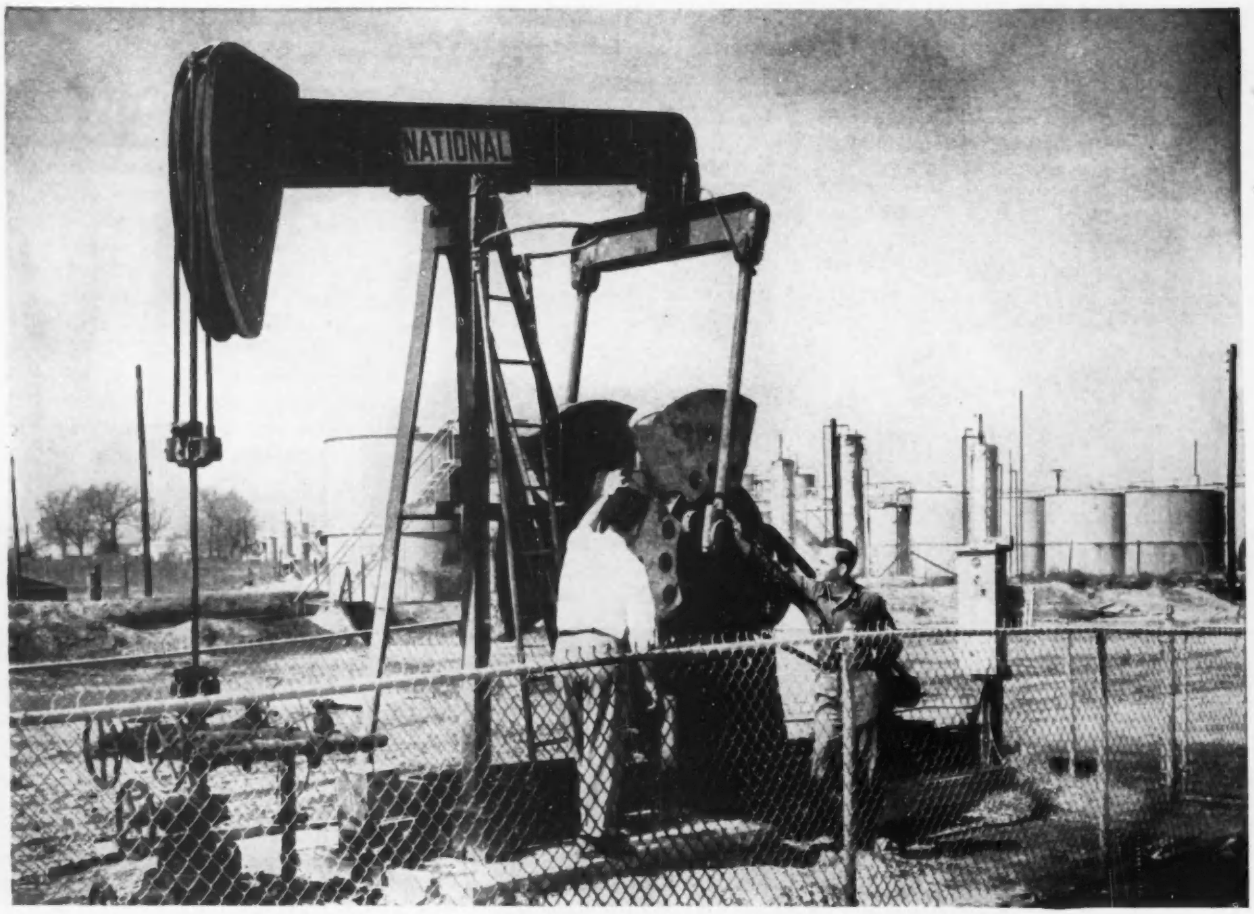
DUCTALLOY castings are made by:
BRAKE SHOE & CASTINGS DIVISION
ENGINEERED CASTINGS DIVISION

AMERICAN **Brake Shoe** COMPANY

230 PARK AVENUE
NEW YORK 17 • NEW YORK

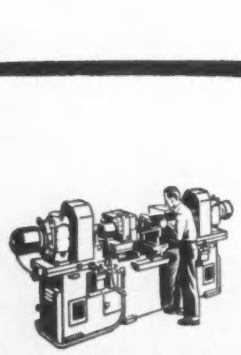
LINK-BELT ball and

...keep company with



The wrist pin bearings in this National E-11SB-57DW Pumping Unit are Link-Belt Double Row Self Aligning Roller Bearings. The beam rating of the unit in polished rod load is 11,000 pounds, and the wrist pin bearings are subject to a 57,000 inch-pound torque.

LINK-BELT ball and roller bearings



Metal Working Machinery

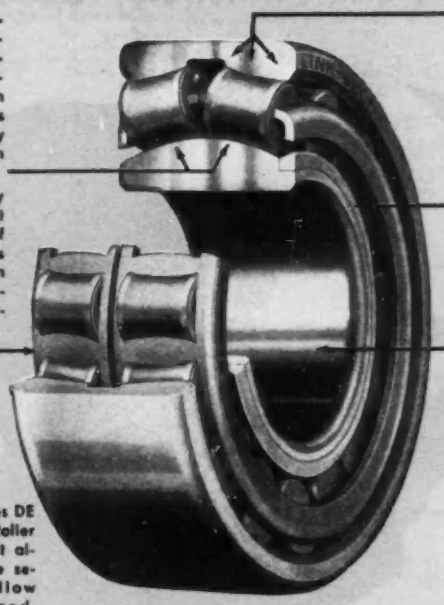
Farm Machinery

Construction Equipment

Textile Machines

roller bearings

America's hardest-working machines



Integral self-alignment—angular contact of concave rollers operating between convex raceways—inner raceway free to move in any direction.

Full load capacity for radial, thrust or combination of radial-thrust loads is assured even with shaft deflection or misalignment.

Accurately formed, hardened steel retainers space and guide the rollers.

Cutaway of Series DE Self-Aligning Roller Bearing. Link-Belt also offers a wide selection of pillow blocks, flanged, flanged cartridge, cartridge, hanger and take-up blocks.

Rollers are naturally positioned by their concave shape, assuring free rolling and eliminating end friction — no pinching or binding of rollers.

Bearing parts are assembled to proper clearance and locked together as a complete assembly.

Straight bore mounting for press fit direct on shafting. Tapered adapter sleeve also available for use with commercial shafting where ready means of removal and installation of bearing are advantageous.

LINK-BELT

BALL and ROLLER BEARINGS

ANY bearing that can take the years of non-stop service an oilfield pumping unit demands—and still roll along efficiently—is the kind you want on your product.

Such performance is why so many machinery manufacturers have standardized on Link-Belt Ball and Roller Bearings. They've learned from experience that these precision bearings give long life under severe conditions.

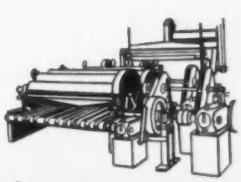
On thousands of applications—whether it's oilfield or farm implement equipment . . . construction or textile machinery or any of the scores of industry's hardest-working machines—top machine designers know that they can rely on Link-Belt bearings.

You can get complete information on the broad line of Link-Belt Ball and Roller Bearings from Data Book 2550. Write or call your nearest Link-Belt office today for your copy.

LINK-BELT COMPANY: Plants: Indianapolis, Chicago, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities.

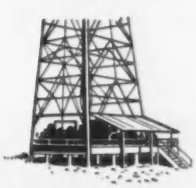
13,221

smooth the path of power for all industry

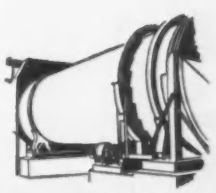


Pulp & Paper Machinery

Materials Handling Equipment



Oil Field Equipment



Processing Equipment

"Sure I know where to get cork-and-rubber gaskets for government jobs. Call Armstrong Cork."

Whenever you need cork-and-rubber gaskets to meet any of the principal government specs, remember that Armstrong can supply them quickly. For Armstrong makes a cork-and-rubber compound to meet each of the 9 types covered by the government specifications listed at the right.

And if you want a new cork-and-rubber material, or a special synthetic rubber compound to meet new volume requirements, our gasket specialists can work with you to develop it.

For samples and full information, call your nearest Armstrong Industrial Division office or see "Armstrong's Gasket Materials" booklet in Sweet's current file for product designers.

Principal Cork-and-Rubber Specifications

Government Specification	Armstrong Material
MIL-G-6183	
Type I Soft	NC-709
Type I Medium	NC-710
Type I Firm	NC-711
Type II Soft	DC-167
Type II Medium	DC-100
Type II Firm	DC-113
MIL-T-6841	DK-153 or RK-304S
MIL-G-6747	DK-149
MIL-G-17539	RK-375

Get This Free Gasket Data Book →

The 24-page manual, "Armstrong's Gasket Materials," gives you information on current government specifications and tentative SAE-ASTM specifications. You'll also find helpful sections on the design and use of gaskets, covering subjects like *Designing Gaskets to Reduce Costs, Practical Tolerances for Resilient Gaskets, Designing for Efficient Sealing.*

For your free copy, write Armstrong Cork Company Industrial Division, 7106 Irvin Street, Lancaster, Pennsylvania.

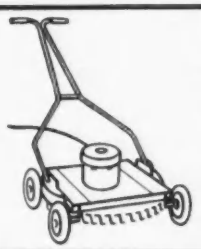
Armstrong's Gasket Materials

TEST your HORSEPOWER sense!

Can you estimate the H.P. these products require?

CHECK ONE: ( ) 3/4-h.p. ( ) 1/2-h.p. ( ) 1/3-h.p. ( ) 1/4-h.p.

Two right answers here! That's because the majority of home freezers are powered with motors of one-fourth or one-third h.p. Delco is a pioneer manufacturer of hermetic motors for freezers and refrigerators . . . motors famous for dependable service over the years.



CHECK ONE: ( ) 1/6-h.p. ( ) 1/4-h.p. ( ) 1/3-h.p. ( ) 1/2-h.p.

Right! The one-third h.p. motor is most favored by lawn mower manufacturers. And Delco Motors are favored, too—for their dependability and long life, as well as their ease of application to any product design.

CHECK ONE: ( ) 1/6-h.p. ( ) 1/4-h.p. ( ) 1/3-h.p. ( ) 1/2-h.p.

That's right—one-third h.p. motors are the popular ones when it comes to powering cellar drainers. Where dependable, trouble-free service counts, Delco Motors are the long-time favorites. Manufacturers know the Delco name gives their products added value.

DELCO

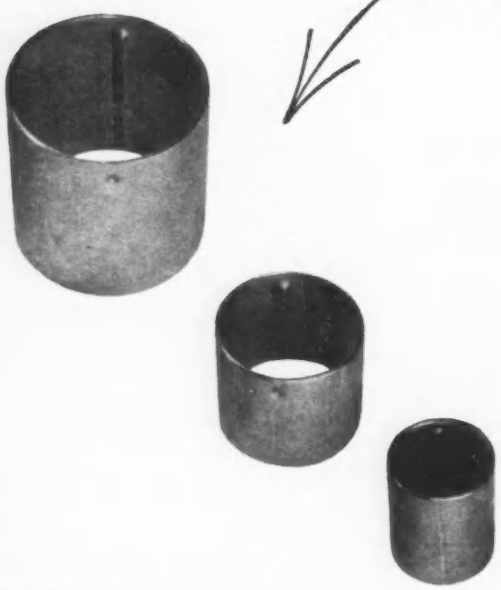
The best running mate your product can have!

DELCO PRODUCTS

Division of General Motors Corporation, Dayton, Ohio

SALES OFFICES: Atlanta • Chicago • Cincinnati • Cleveland • Dallas
Detroit • Hartford • Philadelphia • St. Louis • San Francisco

Dentists Can Tell You Why Stainless Tubing for <u>These</u>



Dental molding flasks and saliva ejector stand up under constant use, because they are made from Carpenter Stainless Tubing. The flasks withstand temperatures up to 1700° F., while the ejector is frequently sterilized.

Fabricators can tell you why it's easy to work with *Carpenter* Stainless Tubing!

Reports from dozens of experienced fabricators tell us that there are two reasons why it's easy to work with this tubing. First, analysis-tolerance-finish (and specials such as hardness) are always just the way you want them. That eliminates a lot of problems at the start of any job. Second, they tell us that the personal help they can get on any Stainless Tubing job helps to keep unit costs as low as possible.

When you want to discuss your design or fabricating problems, call your nearest Carpenter Stainless Tubing Distributor. He will be glad to put his experience to work on your essential jobs, and to help you plan for the future, too.

THE CARPENTER STEEL COMPANY

Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Company
Port Washington, N. Y.—"CARSTEELCO"

Carpenter

STAINLESS TUBING

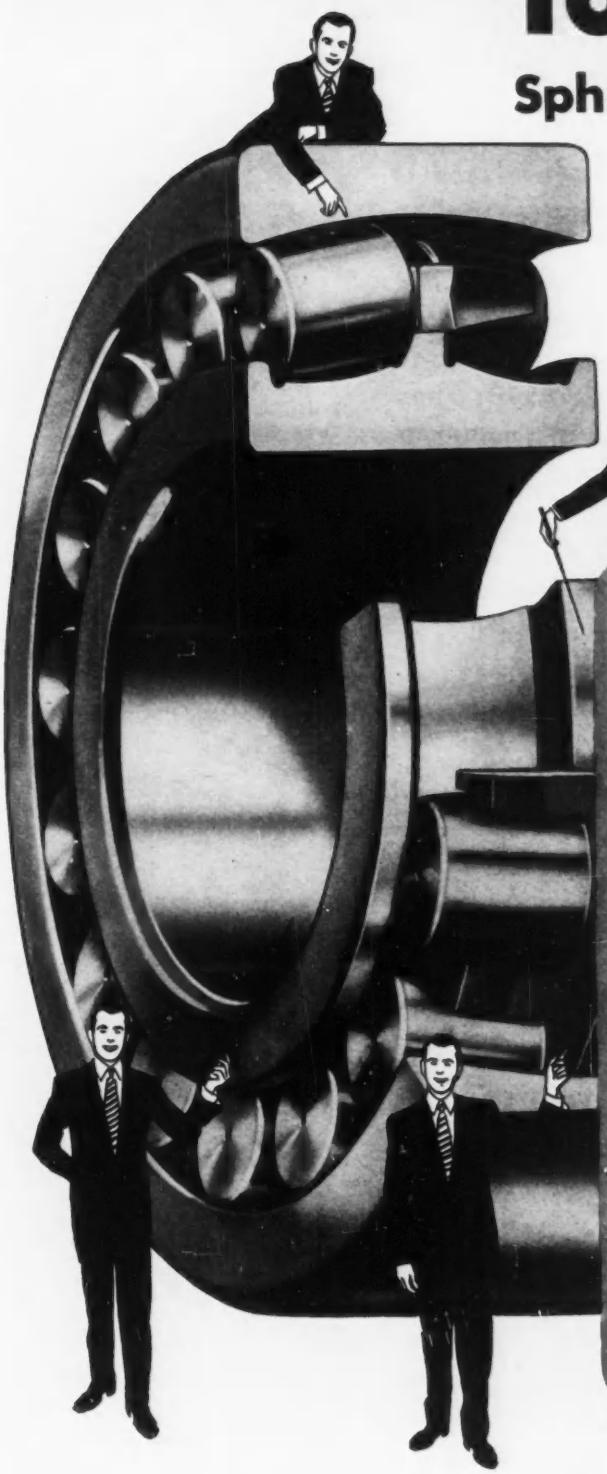
—guaranteed on every shipment

THE U.S. NEEDS YOUR STEEL SCRAP NOW

TORRINGTON

Spherical Roller Bearings

offer you these basic advantages!



- **Accurate geometrical conformity between races and rollers**—for maximum load bearing capacity at all times.
- **Inherent self-aligning feature**—for continuous service and free-rolling even under shock loads and at sustained speeds.
- **All contact surfaces precision ground from the finest of bearing quality steels**—for minimum friction and maximum life under the toughest operating conditions.
- **Races and rollers heat treated according to the most advanced metallurgical procedures**—to insure uniform hardness in all load-bearing parts.
- **Individual one-piece cast-bronze cage for each path of rollers**—to eliminate roller binding and assure freedom of operation.
- **Radial stability provided by land-riding cage and integral flange on inner race**—to give accurate roller guiding.
- **Unit assembly, with sturdy flange and race construction**—for easy, economical handling during installation.
- **Available from stock with either straight or tapered bore**—for shaft or adapter mounting.

These advantages add up to maximum performance for your bearing dollar. That's why it always pays to specify TORRINGTON Spherical Roller Bearings.

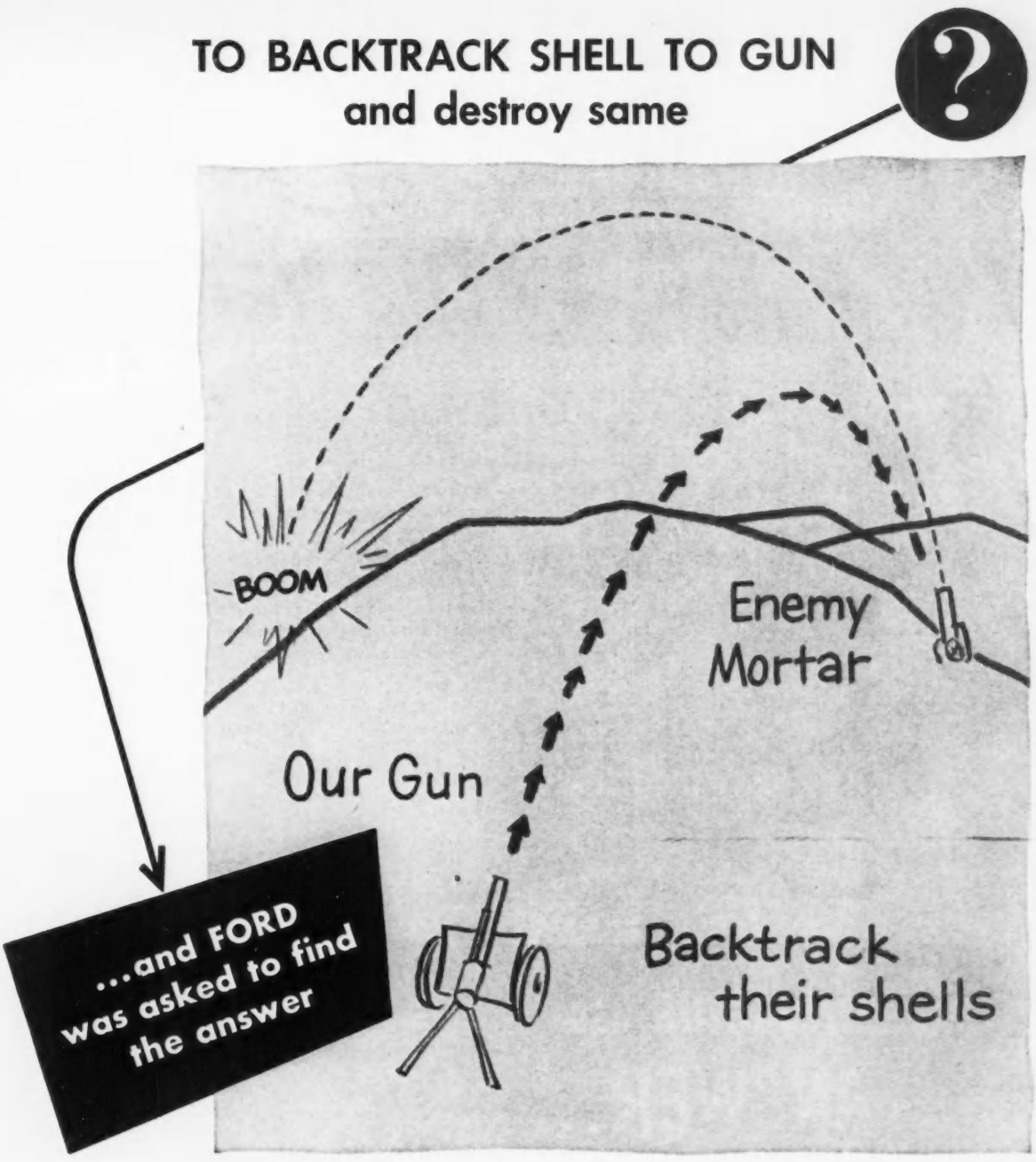
THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.

TORRINGTON SPHERICAL ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

TWO HEADS ARE BETTER THAN ONE
You know your product . . . we know how to produce deep drawn stampings economically. Let's get together! Light weight, strength, and lowered costs may result. They usually do when T & W Stampings are specified
23½" long, 16" wide, 3½" deep
24½" long, 23" wide
10" dia. x 4" deep
8½" long, 6½" wide, 8½" deep
31½" long, 15" wide, 10" deep
Transue & Williams
ALLIANCE, OHIO
Designers and Makers of Deep Drawn Stampings
Sales Offices: NEW YORK, DETROIT, CHICAGO, CLEVELAND, PHILADELPHIA, INDIANAPOLIS

TO BACKTRACK SHELL TO GUN
and destroy same



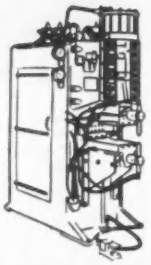
Can projectiles be "seen" approaching and their flight backtracked to locate the mortar or gun that fires them? This problem was simply reconciled with special computing equipment designed to be built right into the gun. The engineering of such a computer, the handling of such ballistic data, all falls into the pattern of previous Ford achievements.

This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic electro-mechanical, magnetic and electronic instruments that bring us our "tomorrow" today. Control problems of both Industry and the Military are Ford specialties.

You can see why a job with Ford Instrument Company offers a challenge to young engineers. If you qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

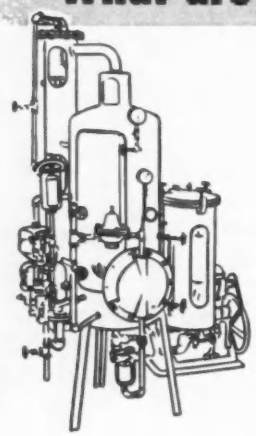
6

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.



WELDING MACHINE

What are your VALVE NEEDS?

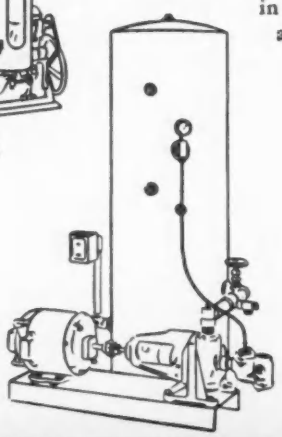


LAUNDRY PRESSING EQUIPMENT

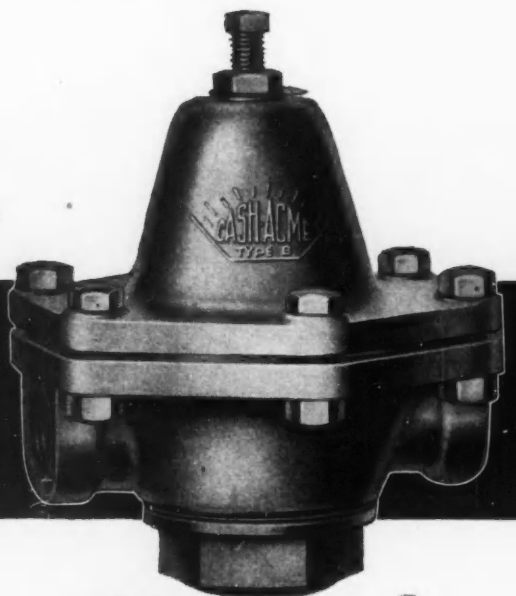
Do you have to meet a lower production cost in the valve you select? Has a certain valve capacity got you stumped? Then call on CASH-ACME.

Many pressure control needs can be filled with a CASH-ACME valve at surprisingly lower cost. If one of our standard valves is not suitable for your requirements, we are able in many cases to modify the standard valve or design a new one for particular requirements.

Mail the coupon below with a brief outline of your installation requirements. A free booklet or catalog on request.



WATER PUMP



Cash-Acme has the ANSWER...

ATTACH TO YOUR LETTERHEAD
A. W. Cash Valve Mfg. Corp.
6662 E. Wabash Avenue
Decatur, Illinois

☐ Please send me your free booklet.

NAME_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

To save time may we suggest a brief outline of your requirements be mailed with this coupon.

CASH ACME

SILENT SENTINEL
Automatic Valves

A. W. CASH VALVE MFG. CORP.
6662 E. WABASH AVENUE • DECATUR, ILLINOIS

They're new
They're high in quality
They're low in price
and they're SOLID BRASS

This new C Series Cylinder Type Lockset is made by Lockwood Hardware Mfg. Co., Fitchburg, Mass., Division of Independent Lock Company. Anaconda Metals in a variety of alloys were especially adapted to its "solid brass" construction.

We're talking about Lockwood's new C Series Cylindrical Type Locksets recently introduced to the trade. An entire new plant was built for their production.

Here, for the first time in Lockwood's history, ease-of-installation, ruggedness, smooth operation, outstanding design and long life were engineered into a lockset in one fell swoop, aimed specifically at the low-price field.

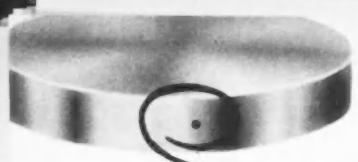
Time-tested brass is used in every wear-and-weather-vulnerable spot: turnbutton, knobs, knob shanks and inserts, roses, latchplate, auxiliary locking plunger — right down to the pins, springs, tumblers and extruded shell of the cylinder lock.

It took a bit of doing to determine the right Anaconda Copper Alloy, in just the right temper, gage and grain size for each of the several different functions and fabricating operations involved. But then, that's been the business of The American Brass Company for a long time. Maybe we can be of service to you? Address: The American Brass Company, General Offices, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

ANACONDA

COPPER · BRASS · BRONZE

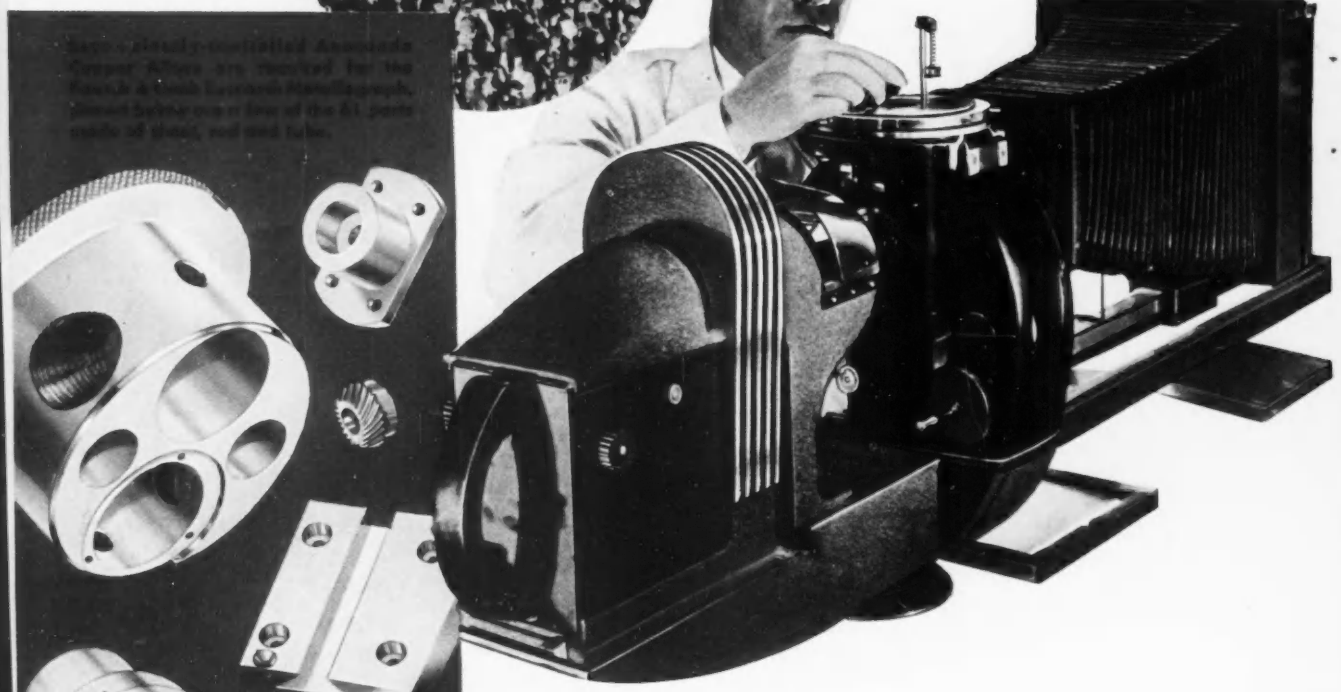
Made by The American Brass Company

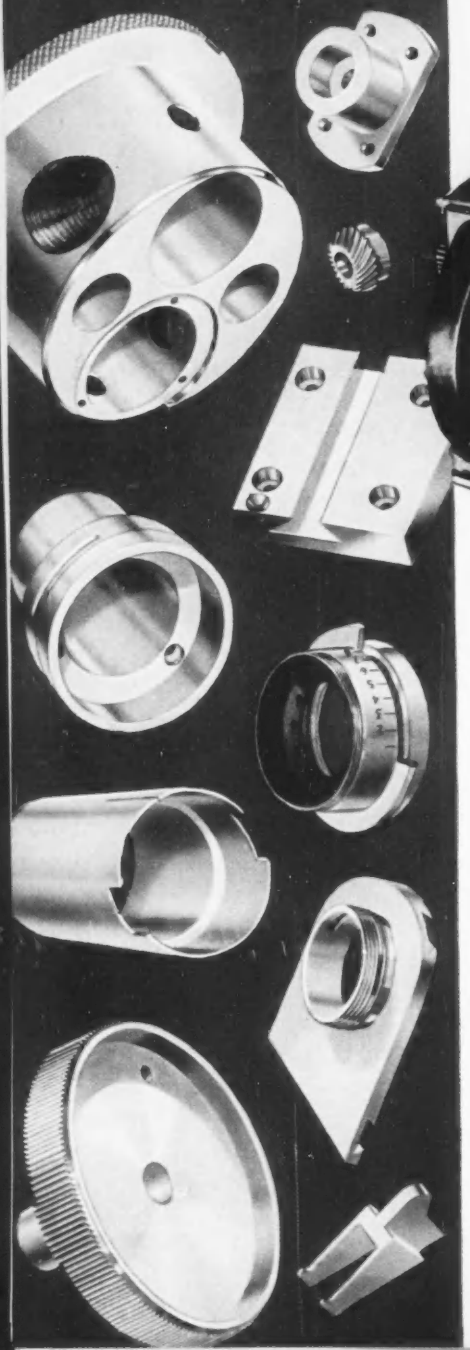


to Bausch & Lomb:

may the second 100 years be as productive as the first!

HERE ARE TWO PICTURES OF THE SAME THING . . . above a section of Tobin Bronze* Rod. At right a micrograph at 75 diameters of a polished and etched specimen cut from the rod. *Reg. U. S. Pat. Off.





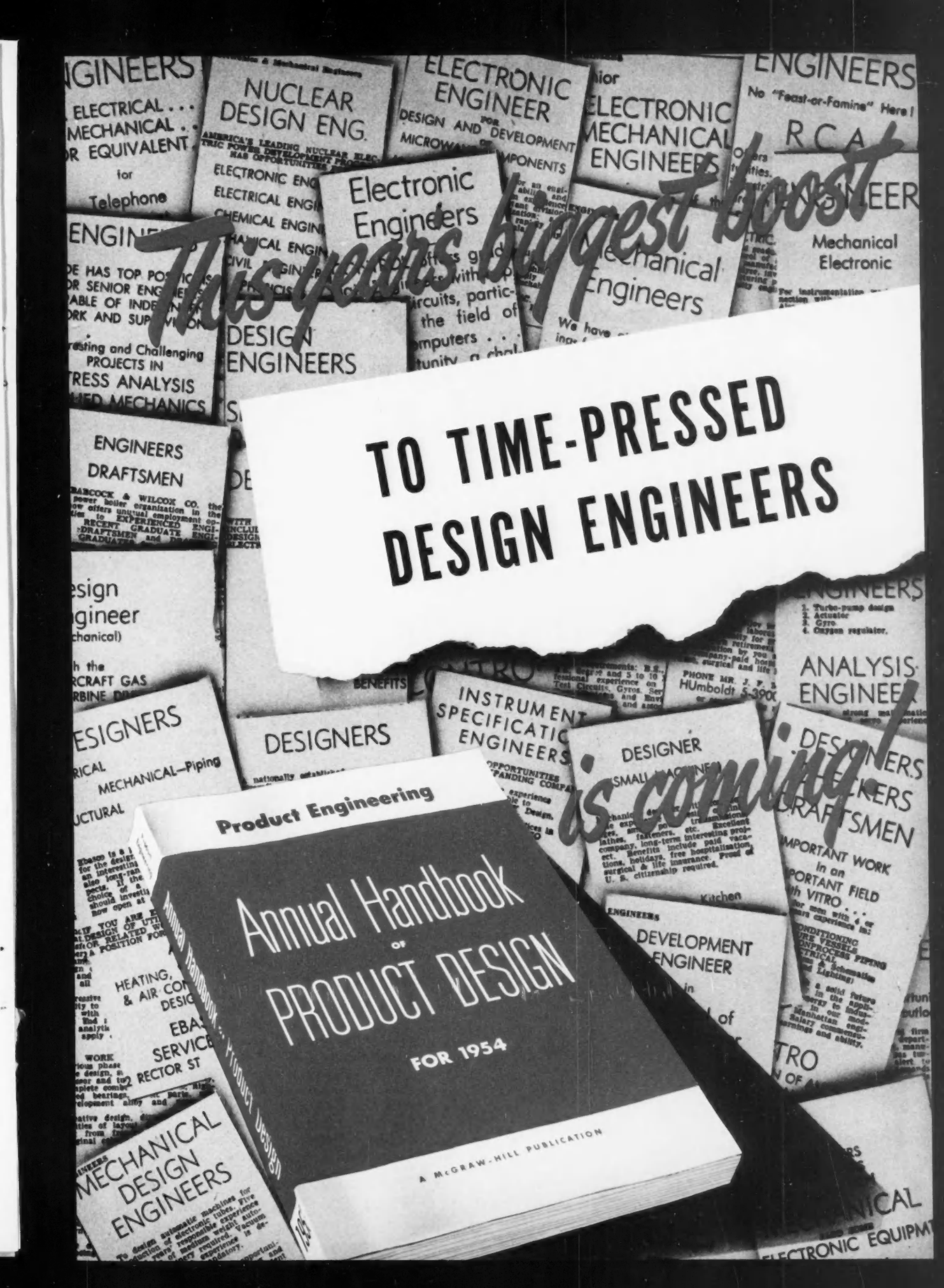
To Bausch & Lomb Optical Co., which this year is celebrating its 100th anniversary of manufacturing fine optical instruments, America owes a debt of thanks. Through its development of scientific equipment, this pioneer optical firm has helped American science and industry to apply modern precision methods to research and production.

One example of fine Bausch & Lomb industrial optical equipment is the B&L Research Metallograph. With this precision instrument a skilled laboratory technician may examine and photograph metal structure at high magnification. To build it Bausch & Lomb uses 61 parts made of seven Anaconda Copper Alloys. Eight parts are formed from tube, 16 from strip and 37 from rod. Of what advantage are these alloys? They provide accurate, smooth surfaces on delicate working parts. They lead to production economies through higher machining speeds and longer tool life.

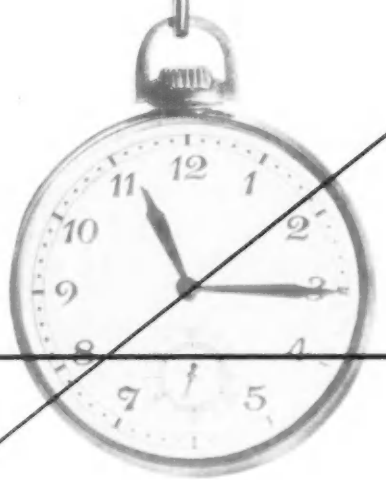
With such a variety of wrought forms available, there's little wonder that so many instrument makers depend on copper alloys . . . from the mills of The American Brass Company. General Offices, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 5308

ANACONDA

COPPER · BRASS · BRONZE made by The American Brass Company


This year's biggest boost
TO TIME-PRESSED DESIGN ENGINEERS
is coming!
Product Engineering
Annual Handbook of PRODUCT DESIGN FOR 1954
A McGRAW-HILL PUBLICATION
NUCLEAR DESIGN ENG.
ELECTRONIC ENGINEER
Electronic Engineers
ELECTRONIC MECHANICAL ENGINEERS
ENGINEERS
No "Feast-or-Famine" Here!
RCA
Mechanical Electronic
DESIGN ENGINEERS
ENGINEERS DRAFTSMEN
DESIGNERS
INSTRUMENT SPECIFICATION ENGINEERS
DESIGNER
DEVELOPMENT ENGINEER
ANALYSIS ENGINEER
MECHANICAL DESIGN ENGINEERS

When you wonder
how you'll find the time
to get abreast of this year's
big developments
in product-design engineering



FORGET IT!

That's why we edit the

NOW THERE WILL BE TWO

. . . two great HANDBOOKS, when the 1954 edition joins the 1953 one next November. They will work as a great team for you . . . and the 1954 HANDBOOK will carry a *complete index* of the 1953 issue's editorial pages. You'll find this a big advantage when you want, fast, all the information *both* HANDBOOKS have to offer in any given field of your interests.

LAST YEAR, when *Product Engineering's* first Annual HANDBOOK of Product Design was published, there was already an acute shortage of design engineers. Hundreds of you have since told us how much this HANDBOOK for 1953 has meant to you in making your burdens quite a bit easier . . . by saving you many hours of hard-pressed time . . . and by bringing you reports on significant design developments, and new products, that you would otherwise have missed.

This year, the shortage of design engineers is even more acute, and your need for an Annual HANDBOOK's time-saving help is undoubtedly even greater. Which is why we're particularly glad to tell you that . . . if you're worried about how you can *ever* find the time to do the amount of reading needed to keep abreast of every new design development important to you . . . you can pretty well relax.

Product Engineering's editors are once again doing that job for you. And the really outstanding, and long-useful, result will come your way in a brand-new Annual HANDBOOK of Product Design for 1954.

It will be even better and more informative than last year's great HANDBOOK. In addition to even more facts and ideas that you can put to work, you'll find many new features. Most of them were suggested by *you*, our *Product Engineering* readers . . . and *all* of them are designed to make the HANDBOOK for 1954 an even faster-to-use, easier-to-use guide to *what's newly significant* in a full year's design research and dvelopment.

More news about the HANDBOOK for 1954 is on the next page. As a *Product Engineering* subscriber, you will receive your new HANDBOOK, in Mid-November, as part of your regular subscription. And if, by chance, you are not now a *Product Engineering* subscriber . . . get your subscription in to us without delay. This is the *only* way you can be sure to receive a copy of the 1954 HANDBOOK.

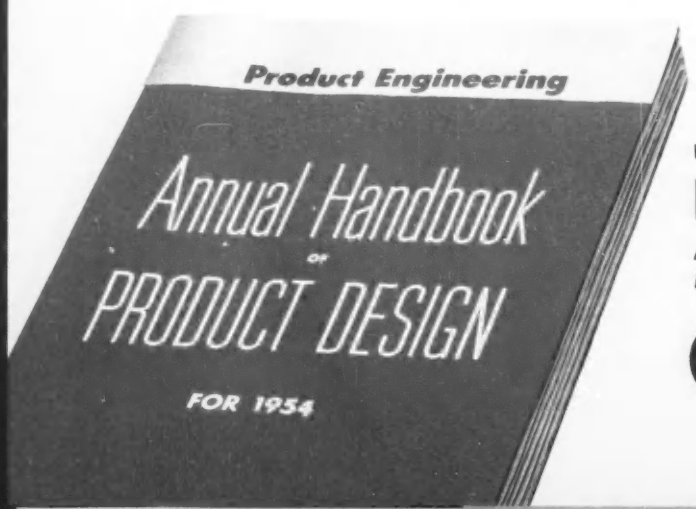
Annual HANDBOOK for you

To bring you this year's big developments in product-design engineering ...as reported from around the world

10 BIG SECTIONS

- General Engineering
- Metals and Alloys
- Non-Metallic Materials and Finishes
- Fabrication and Production Processes
- Power Transmission
- Mechanical Parts and Design Analysis
- Fastening and Joining
- Motors, Engines, and Controls
- Electrical and Electronic Components
- Hydraulic and Pneumatic Equipment

HEAVY, DURABLE COVERS • SPECIAL "LIE-FLAT" BINDING • THUMB INDEXING TO SPEED YOUR REFERENCE TO EVERY SUBJECT • RELATED ADVERTISING DIRECTLY FOLLOWS EDITORIAL PAGES IN EACH SECTION • COMPLETE EDITORIAL/ADVERTISING INDEXES



PUBLISHED BY

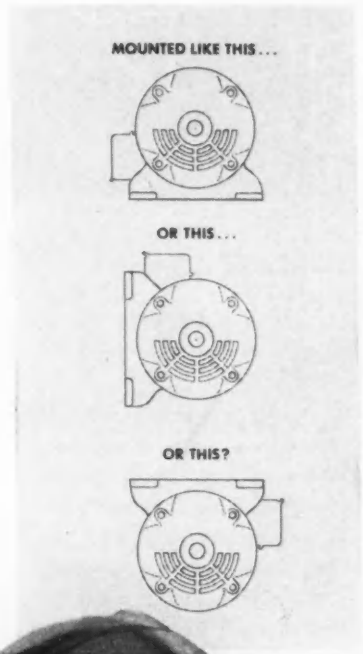
Product Engineering

A McGraw-Hill Publication
McGraw-Hill Building, New York 36

ABP ABC

FOR AIR HANDLING

Is your motor *really* dripproof?



. . . AT ANY ANGLE OF MOUNTING— Do you see a ventilating opening in the frame? Then the motor is probably not dripproof when side wall or ceiling mounted. You need a special motor for these mounting positions . . . with special protection over frame openings. But . . .

You can save the costs of specials with Life-Line motors. Solid frame construction eliminates frame openings. All ventilation is accomplished through the end brackets. Simply rotate the 4-position brackets and the Life-Line is dripproof—for side wall or ceiling mounting.

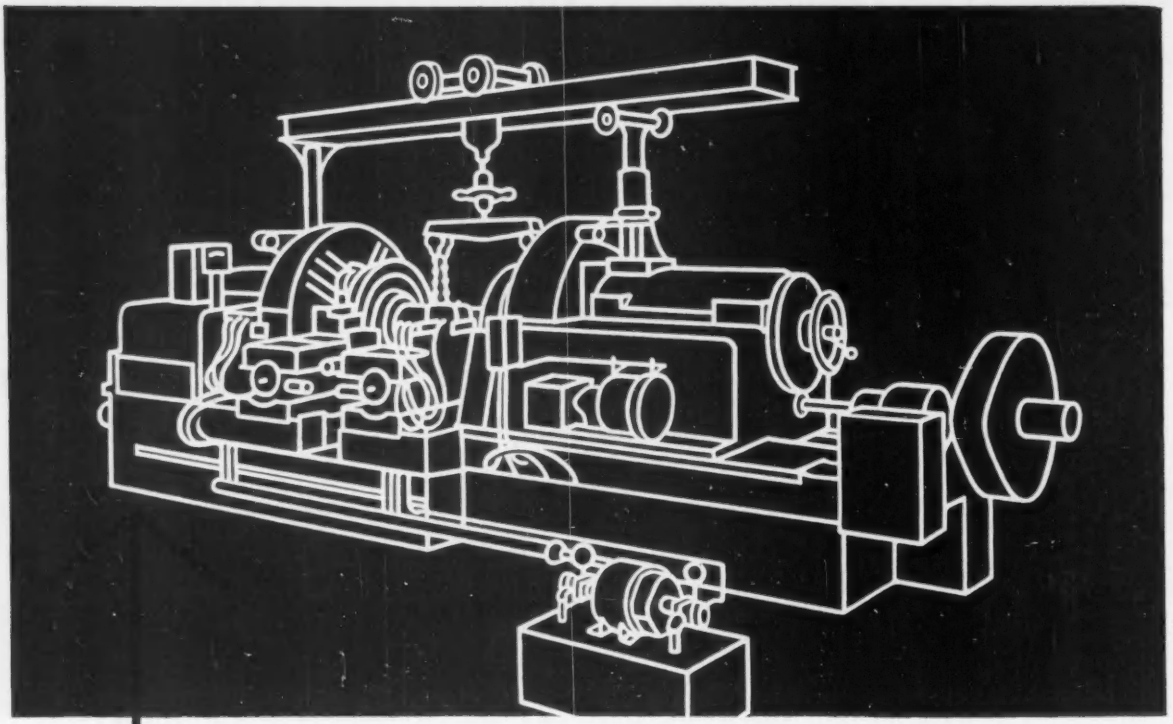
Dripproof conduit box can be rotated also. Plenty of knockouts give maximum possible connections. And, because a Life-Line motor needs no further lubrication, you can crowd it into cramped quarters . . . mount it in "hard-to-get-at" locations—and forget it. Thus, you get maximum mounting flexibility for difficult mounting problems.

It costs no more to get these "special" features in a standard motor. Simply specify Life-Line as the drive for your equipment. Ask your local Westinghouse representative for details and a copy of booklet B-3842, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-21583-A

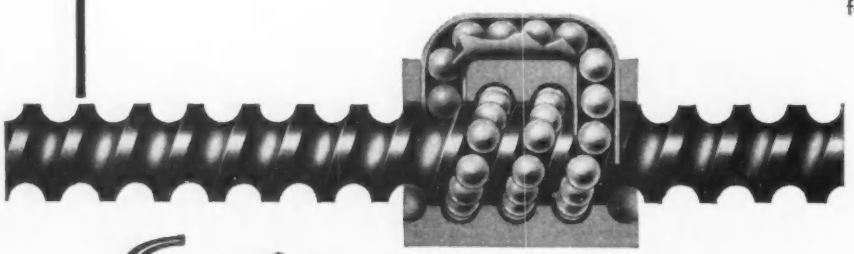
YOU CAN BE SURE...IF IT'S

Westinghouse



SAGINAW BALL BEARING SCREWS IMPROVE PERFORMANCE OF NILES 52" CAR-WHEEL LATHE

The Saginaw Recirculating Ball Bearing Screw and Nut has proven particularly effective for both longitudinal and cross-movement slides in the powerful 52" Niles railroad car-wheel lathe manufactured by the Niles Tool Works Company, Division of the Baldwin-Lima-Hamilton Corporation of Hamilton, Ohio. As the engineers of Niles Tool Works state: "The Saginaw screws withstand the arduous work loads of tool slides in constant railway shop use where, in many cases, as much as ¾" of material is removed in continuous automatic feed." Niles' engineers further state: "Friction is greatly reduced, as compared with ordinary translating nuts, to such an extent that the power factor formerly required in actuating the slides is greatly reduced." Niles' engineers go on to say: "Since the installation of your product we have had no service complaints whatsoever from the field." • Saginaw screws are proving extremely useful wherever rotary-to-linear force is required in such applications as aircraft actuators • machine tool feed screws • automobile jacks • convertible top lifts • automobile seat adjustors • manual and power steering gears • trailer retractable landing gears • ship and submarine applications • and many others. For more complete information, write for engineering data book.



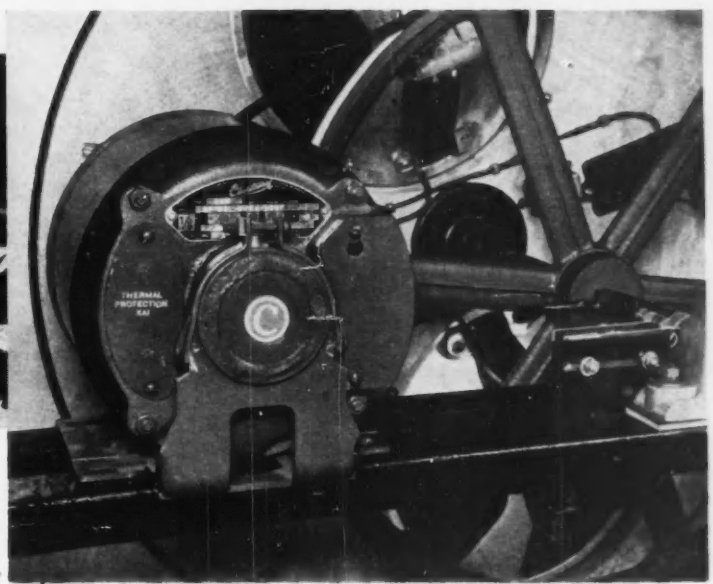
53

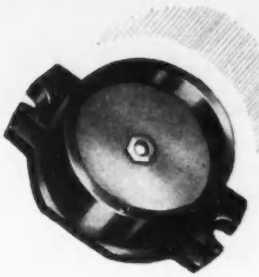
Saginaw STEERING GEAR

DIVISION, GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN

MANUFACTURER OF SAGINAW POWER STEERING FOR PASSENGER CARS, TRUCKS AND TRACTORS

KLIXON PROTECTORS HELP ALLEN ORGAN MAKE *Sweet Music*





by preventing motor burnouts

The Allen home organ represents a new and distinct achievement in the industry. It will produce directly from the keyboard true bell tones such as Chime, Glockenspiel, Music Box as well as Marimba tones, Harp tones, etc., through the regular organ mechanism.

To keep the motor operating in the "Gyrophonic" speaker mechanism Allen Organ Company uses motors with built-in *Klixon Protectors.*

Here's what Mr. Jerome Markowitz, president, has to say about Klixon Protectors:

"We insist that the motor which is included in the "Gyrophonic" speaker mechanism of our electronic organ be equipped with Klixon overheat protectors. This not only offers motor protection, but also prevents disintegration of the morale of a customer whose instrument 'burns out.'"

You, too, can provide your dealers and consumers with motor burnout protection by requesting and specifying that your motor manufacturer supplies you with motors that have Klixon protectors built in. The additional cost is exceptionally low, while the benefits are extremely high.

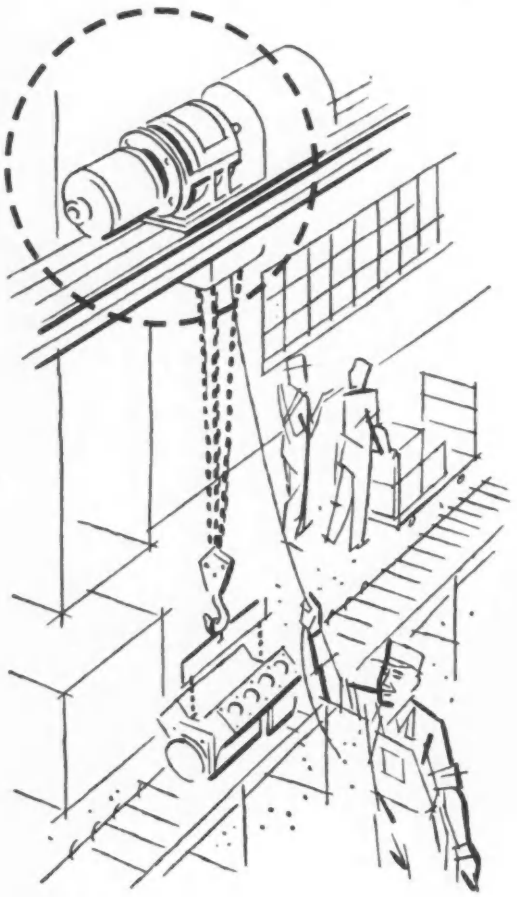
KLIXON

SPENCER THERMOSTAT

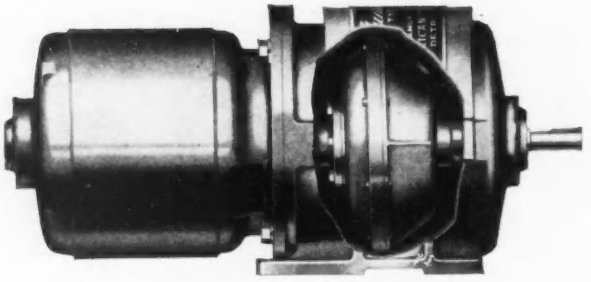
Division of Metals & Controls Corporation

906 FOREST ST., ATTLEBORO, MASS.

Save with
GÝROL FLUID DRIVE
on electric traveling cranes



Lower initial cost: Fluid Drive units use a standard squirrel cage motor. Compared to a wound rotor motor, you save on motor, controls and installation costs. *Lower maintenance cost:* Controls are vastly simplified. No brushes, contacts or resistors to clean or replace. *Lower HP motors:* With Fluid Drive, motors reach 80-90% of full load speed before engaging the load. Thus, lower HP motors can often be used, improving over-all plant power factor. *Less pendulum action:* Fluid Drive provides smooth, stepless acceleration. Puts the load in motion with minimum jerking or swinging.



Cutaway view of Type TM Gýrol Fluid Drive unit

Advantages of American Blower Type TM Gýrol Fluid Drives

- Provides smooth flow of power. Shocks are absorbed in a cushion of oil. There's no metal-to-metal contact between driving and driven machinery.
- Offers by its inherent shearpin action, selective overload protection for both motor and driven machinery. Decreases machine "down" time.
- Available as a complete packaged unit suitable for either direct or belt connection to the driven machine. Minimizes alignment problems.

Free trial units are available to original equipment manufacturers

AMERICAN BLOWER

American Blower Corporation, Detroit 32, Michigan

Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS

New Suit

for the New Snorkel Pen

"Snorkel" is a trade-mark of W. A. Sheaffer Pen Co.

You can tell right away that the new Sheaffer Snorkel pen is a remarkable writing instrument. It fills without wetting the nib. Its Snorkel tube extends, draws up ink, retracts. No mess at all.

Its styling completes this feeling of cleanliness and efficiency. The barrel, cap, plunger knob and gripping section are made of BAKELITE C-11 Plastic. They're precisely molded, richly colored, strong. Dimensionally stable, the C-11 Plastic assures a long-lasting close fit for the small, finely-threaded sections. Resistance to abrasion, chemicals, and perspiration assures a lifetime of beauty.

BAKELITE C-11 Plastics are acrylonitrile-styrene copolymers that have several distinct advantages over both acrylic and styrene plastics. Their tensile and flexural strengths are 45% greater than those of standard polystyrenes. They withstand contact with food, chemicals, soaps, detergents, coffee, tea, citrus peels, most oils and cosmetics.

Consequently BAKELITE C-11 Plastics are being used more and more for housewares, packaging, and precision applications such as high-quality drafting instruments. Perhaps your product could join the Sheaffer Snorkel fountain pen on this growing list of successful applications in widely varied fields. For information, write Dept. QL-61.

BAKELITE
TRADE-MARK

C-11 PLASTICS

TRADE MARK

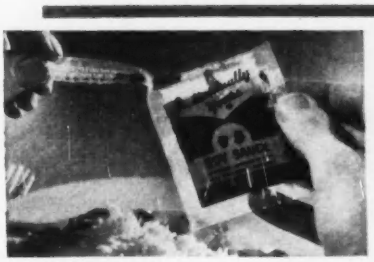
BAKELITE COMPANY

A Division of
Union Carbide and Carbon Corporation

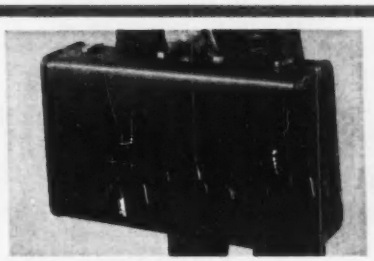
UCC

30 East 42nd Street, New York 17, N. Y.

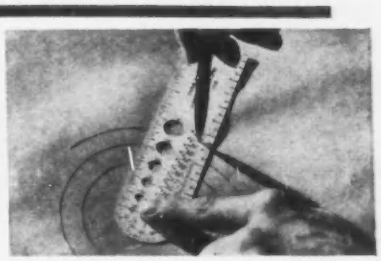
In Canada:
Bakelite Company (Canada) Ltd., Belleville, Ont.



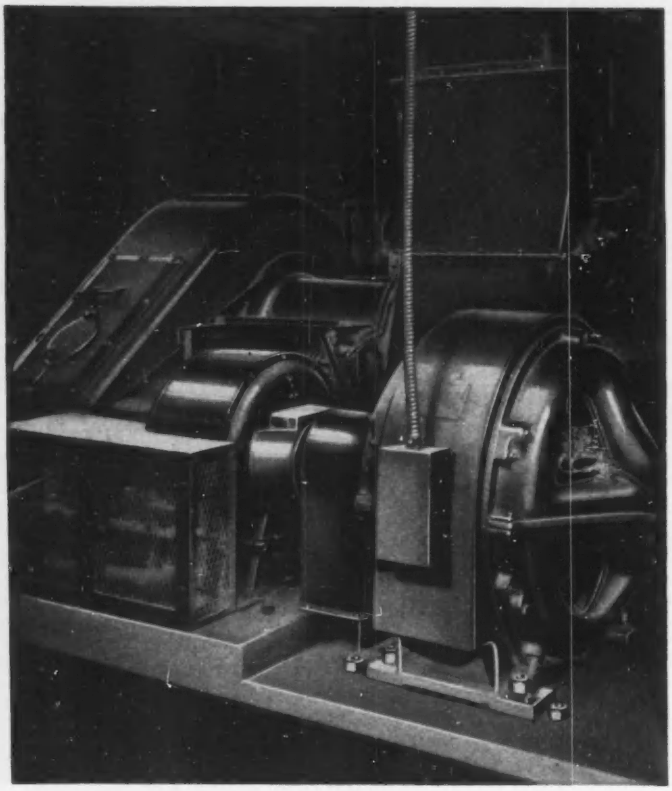
CONTROLLED-FLOW pouch of cellophane with BAKELITE Polyethylene film laminated to inner side has "tortuous channel" patented spout that emits liquid contents when envelope is squeezed. Made by Purity Pac, Inc., Unionville, Conn.



LIGHTWEIGHT LUGGAGE has transparent coating based on VINYLITE Resins over its printed and colored heavy kraft paper covering. Surface resists moisture, abrasion, scuffing, and scraping. Made by Neevel Mfg. Co., Kansas City 1, Mo.



DRAWING INSTRUMENT of VINYLITE Plastic Rigid Sheet is combination compass, scale, square, protractor, and lettering guide. Dimensionally stable, printed, resistant to moisture, oil, ink, most chemicals. By Shaw-Barton, Inc., Coshocton, Ohio.



Model 8W Dynamatic Water-Cooled Coupling used to obtain adjustable speed from 200 HP, 720 RPM synchronous motor to drive a Plasticator carrying rubber from a Banbury Mixer in the plant of a large tire manufacturer.

DYNAMATIC®

WATER-COOLED POWER COUPLINGS

WIDE SPEED RANGE
INSTANTANEOUS RESPONSE
ACCURATE SPEED CONTROL
STEPLESS SPEED ADJUSTMENT
SMOOTH TORQUE TRANSMISSION
TOTALLY ENCLOSED
SIMPLE • QUIET
COMPACT • EFFICIENT

Provide Adjustable Speed Drive with any AC Motor

The Dynamatic Coupling transmits rotation from a driving to a driven member without mechanical contact—with stepless adjustable control and with almost instantaneous response. It is a simple and effective method of providing adjustable speed from a constant speed source (or vice versa) with full-torque starts. The addition of an eddy-current brake will provide smooth controlled deceleration.

Effective water-in-the-gap cooling makes possible large capacity in small space, and the construction provides complete protection of the interior of the coupling against atmospheric impurities.

A standard range of sizes of Dynamatic Water-Cooled Couplings is available for transmitting torques of 50 pounds feet up to approximately 5,000 pounds feet. Many other sizes up to and including single units for handling 200,000 pounds feet of torque are in service and units of larger capacity can be built to order.

Write for Illustrated Bulletin WC-1

DYNAMATIC® CORPORATION • KENOSHA WISCONSIN

Subsidiary of EATON MANUFACTURING COMPANY, Cleveland, Ohio

Dynamometers • Oil Well Draw-Works Brakes • Adjustable-Speed Couplings • Eddy-Current Brakes
Ajusto-Spedes • Shovel Clutches • Press Drives • Lift Truck Clutches • Electronic Controls

NYLOK

NOW! ONE-PIECE

Self-locking Bolts and Screws . . .

Eliminate costly safety wiring, lock washers, jam nuts!

Now you can do a real fastening job, put your product together faster, and drastically reduce manufacturing and maintenance costs. Here's how:

No other method equals the Nylok principle of locking threads securely in any position – *seated* or *unseated*. The smooth wedging action of the nylon insert does it! The lock is vibration-proof, and the ONE-PIECE construction ends laborious fussing with separate auxiliary parts, such as safety wiring, lock washers or jam nuts. The lock is always there – the operator can't forget to apply it. Extra security and ease of service give your product enhanced sales value – and you save plenty on assembly operations.

ACTS AS A SEAL, TOO

Nylok bolts and screws also provide a leakproof seal where liquids are present. No dimensional changes are required for their use, and full tensile strength is retained. Will not mar mating surfaces and can be used over and over again.

HOW NYLOK LOCKS:
Resilient nylon plug (A) sets up lateral thrust, smoothly wedging mating threads together (B). All of locking action is on the threads; head is not stressed. Locking is positive, seated or unseated.

IMMEDIATELY AVAILABLE

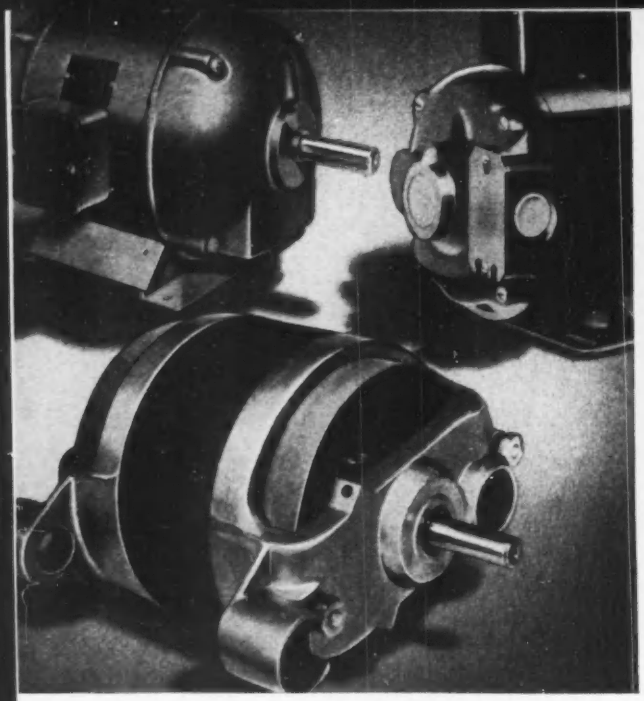
SIZES #6 UP;
LENGTHS ⅜ INCH UP

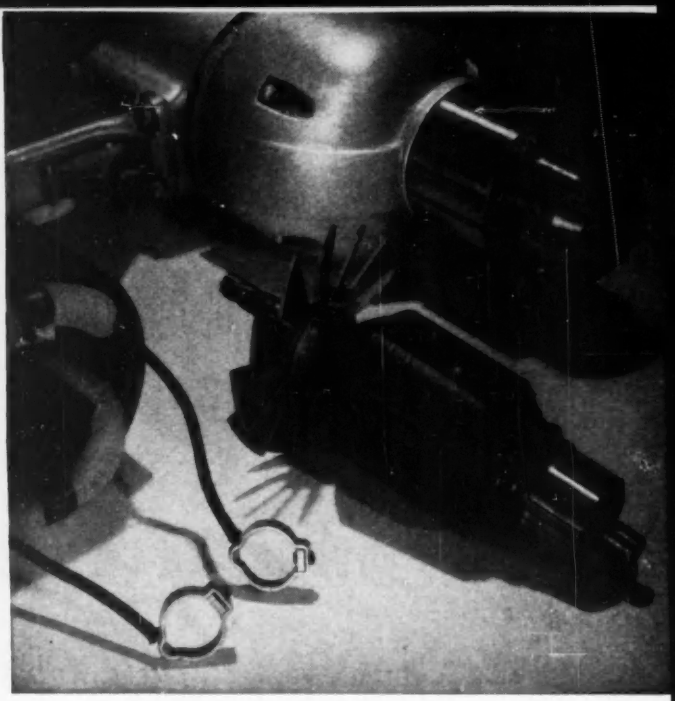
The NYLOK CORPORATION, 475 Fifth Ave., New York 17, N. Y.
FACTORY: Elmira Heights, N. Y.
Manufacturers of Nylon-Locked Fasteners. Covered by U. S. patents and patents pending.

Please send Bulletin 7 on Self-Locking Bolts and Screws.

Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

USE THE COUPON FOR QUICK INFORMATION





Complete Motors ... or Motor Parts

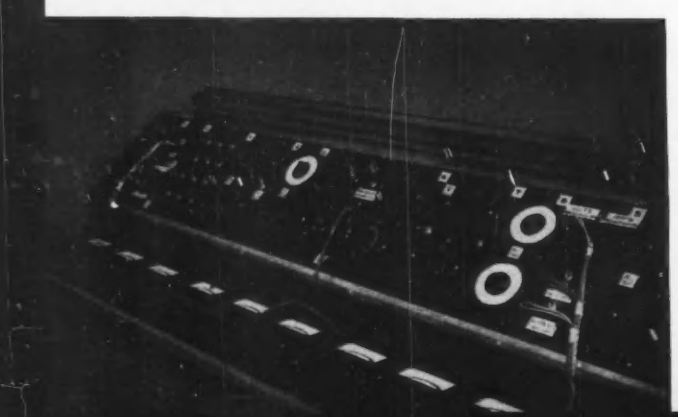
Let your design problem make the choice!

Standard motors and matched motor parts represent only the beginning of what R & M is qualified to build! Special R & M fractional-horsepower with *any* housing design—or specially designed motor parts to fit your housings—are regular R & M contributions to products such as those listed at right:

Portable Saws	Vacuum Cleaners	Portable Grinders
Drills	Files	Sirens
Nut Setters	Sanders	Hair Driers
Hammers	Pumps	Advertising Devices
Routers	Compressors	Ventilating Equipment
Screw Drivers	Hones	Oil Burners
Hedge Trimmers	Business Machines	Surgical Instruments
Lawn Mowers	Cast Cutters	Grease Guns
Nibblers	Food Mixers	Vibrators
Lock Mortisers	Polishers	Die Sinkers
Valve Grinders	Planers	Waxers

The machine that tests motor performance . . . in minutes instead of months!

Formerly it took months to do a really thorough job of calculating motor performance and requirements for a given job. Now, using the unique R & M "Electrical Slide Rule," the performance of any one motor design can be calculated in about 20 minutes! Result? R & M can engineer a motor to your exact requirements . . . thoroughly, accurately, *and in time to meet your production and marketing schedules!*



You can expect quality . . . from every Robbins & Myers motor!

Here, for example, are some of the quality features built into R & M universal motor parts:

1. Every field coil has paper in the slots—in addition to standard taping. More insulation means longer motor life, fewer failures.
2. Insulating material is selected for the job. For example, glass insulated wires are used in sander and saw motors.
3. R & M motors are varnish-dipped and baked—as much as *three times* when service requires it.
4. Standardized commutators and laminations—for mass-production at no sacrifice in quality.
5. Diamond-turned commutators . . . for greater concentricity and smoother surface finish. Brushes last longer!
6. Matched Motor Parts are precision-built, 100%-tested, dynamically balanced, fully interchangeable.

How to select the best Fractional Horsepower Motors FOR MACHINES, POWER TOOLS, APPLIANCES

The most important single factor in motor performance is *selection* of the right motor for the job. That's why R & M offers such a wide variety of types and sizes of motors and motor parts. From these many standard and special-standard types we can, in most cases, help you select the motor to help give your product the best all-around performance.

We Also Custom-Design, Economically!

Your problem may require a custom-designed motor. If so, we'd much rather work out a special motor for you than see you take an "off-the-shelf" compromise.

Ordinarily the extensive calculations required make custom-designing pretty expensive. We've licked that problem, too, with the unique R & M "Electrical Slide Rule." This is an electrical motor-performance calculator. With it, the designer can reduce the work of a whole day or two to about twenty minutes! Naturally you and we both benefit.

Some Other Advantages of R&M Motors

R & M offers some special construction features: extra insulation; glass insulation where heat requires it; diamond-turned commutators; extra varnish treatment; a gratifyingly low failure rate.

As a pioneer in the small motor field, we have designed and built millions of small motors for thousands of different applications. And so we naturally feel well qualified, with engineering skill and experience, and extensive manufacturing facilities, to do an exceptionally good job for you. At least, it won't cost you anything to find out.

Let Us Tell You More

Call the nearest branch office for an R & M Motor Specialist—or write us for the information in which you are interested. Use the check list below.

ROBBINS & MYERS, INC., MOTOR DIVISION,
Springfield 99, Ohio:

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ Universal and DC Motors
- ☐ R & M "All-Weather" Motors—up to 125 HP
- ☐ Please have a Motor Specialist call

*Product we manufacture:*_____

*Name*_____ *Title*_____

*Company*_____

*Street*_____

*City & State*_____

R&M MAKES BOTH!
Fractional horsepower motors and parts . . . from 1/200 h.p.

If it's an R&M, it's the Right Motor!

Integral Horsepower motors; famous R&M "All-Weather"* motor with sealed bearings. Up to 125 h.p.

**"All-Weather" is an R&M trademark*

ROBBINS & MYERS, INC.
SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

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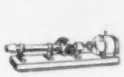
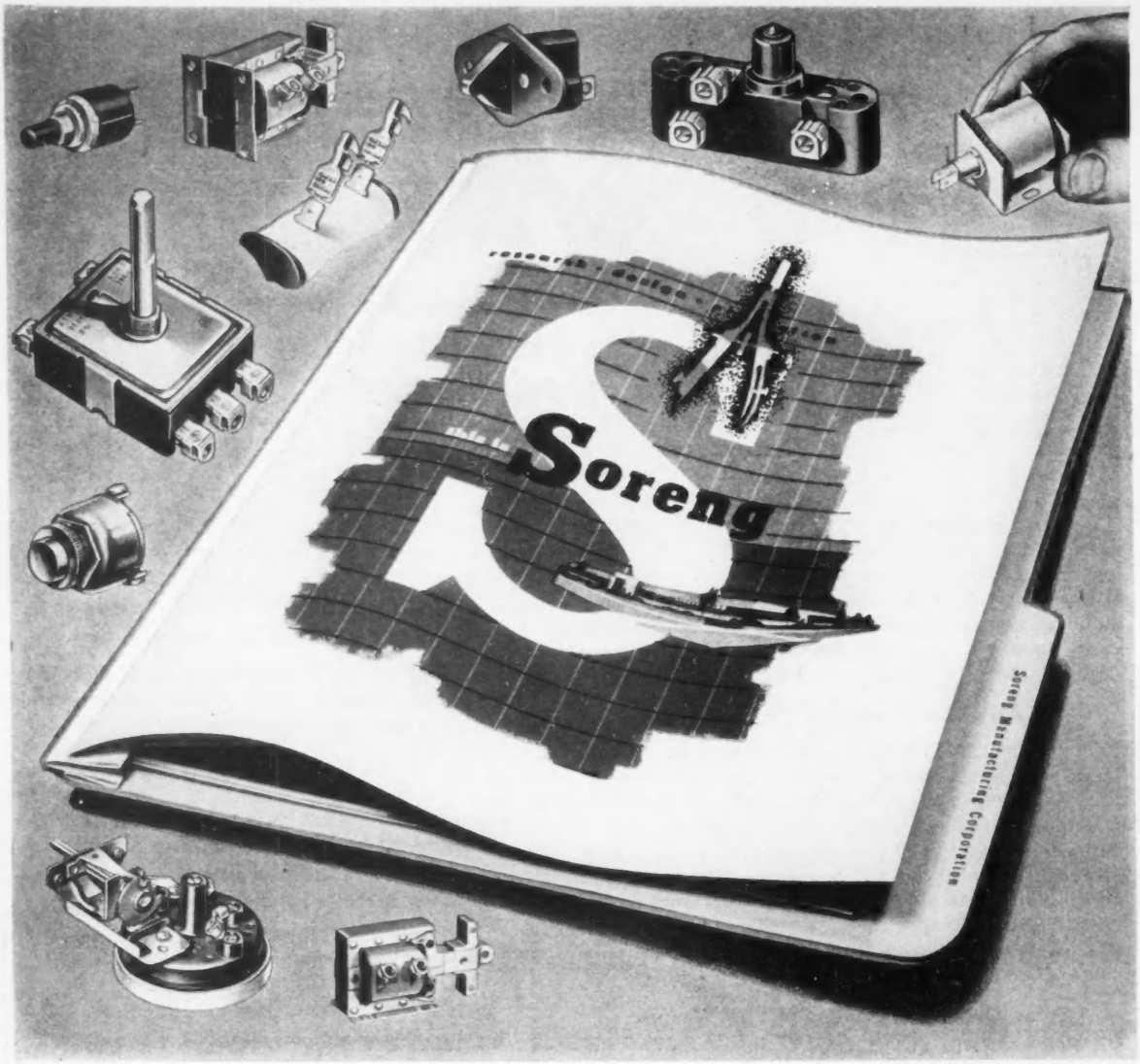

Moyno Pumps

Propellair Industrial Ventilating Equipment



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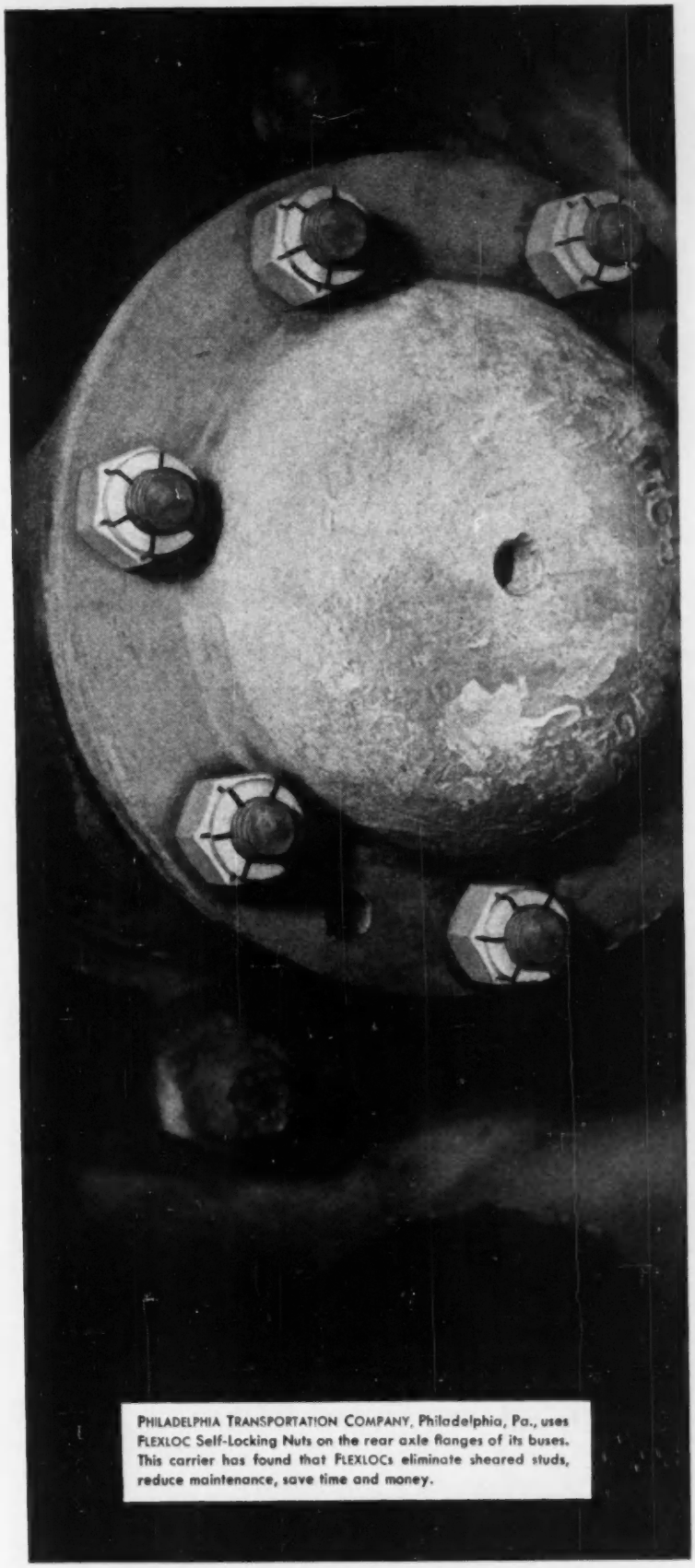
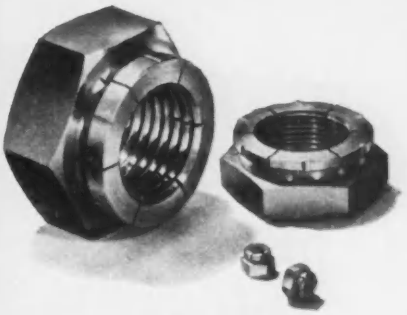


PHILADELPHIA TRANSPORTATION COMPANY, Philadelphia, Pa., uses FLEXLOC Self-Locking Nuts on the rear axle flanges of its buses. This carrier has found that FLEXLOCs eliminate sheared studs, reduce maintenance, save time and money.



How FLEXLOC locknuts work

FLEXLOCs lock and stay put on a threaded member regardless of the vibration encountered. Here's how they work. The slotted top or locking section is divided into six equal, flexible segments, closed in to make the inside diameter of the nut smaller than that of the companion bolt. When the FLEXLOC is applied, these are expanded by the bolt. The spring tension of the resilient segments locks the nut securely at any desired position on the bolt once the locking threads are fully engaged.

FLEXLOCs can be used over and over again. When expanded by the bolt, the locking section remains within the elastic limit of the metal. This permits the locking segments to return to their normal position, ready for reapplication to the bolt.

FLEXLOCs are one piece, all metal—nothing to assemble, come apart, lose or forget. They can be delivered in any quantity in a wide range of sizes. Stocks are carried by industrial distributors everywhere. Write for literature and samples. SPS, Jenkintown 28, Pa.

FLEXLOC®

LOCKNUT DIVISION

SPS

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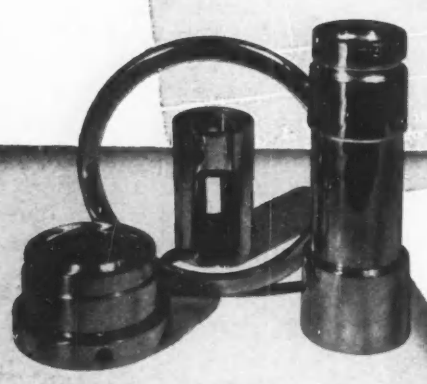

The sleeve bearing is not complex in structure; it conforms readily to design requirements; it is easily installed. Cast Bearing Bronze is the most adaptable of all sleeve bearing materials; it possesses excellent anti-friction properties. With proper film lubrication, its coefficient of friction is as low as can be obtained with any other bearing type. A successful Bunting Bronze bearing installation is readily attainable. We ask the opportunity to work with you, and to quote on your requirements.

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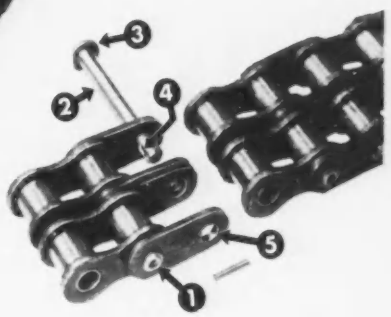
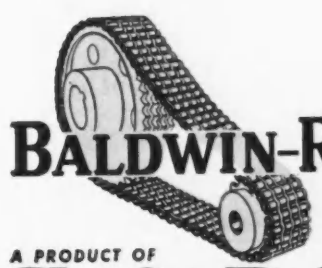


HERE IT IS: One end of the single pin coupler link is firmly riveted to the adjacent link (1). The unique coupler pin (2) has a spun washer (3) on one end, the other has a milled flat (4) and locking pin. The pin is an easy fit through the chain except for the milled flat end which is press-fitted into a special matching hole (5) of the single pin coupler plate. You need only drive the pin the length of its milled flat in assembling or disassembling the chain. It's easy . . . saves time, effort and money.



BALDWIN-REX ROLLER CHAINS

A PRODUCT OF **Chain Belt** COMPANY OF MILWAUKEE

53-405

CHAIN BELT COMPANY
Baldwin-Duckworth Division
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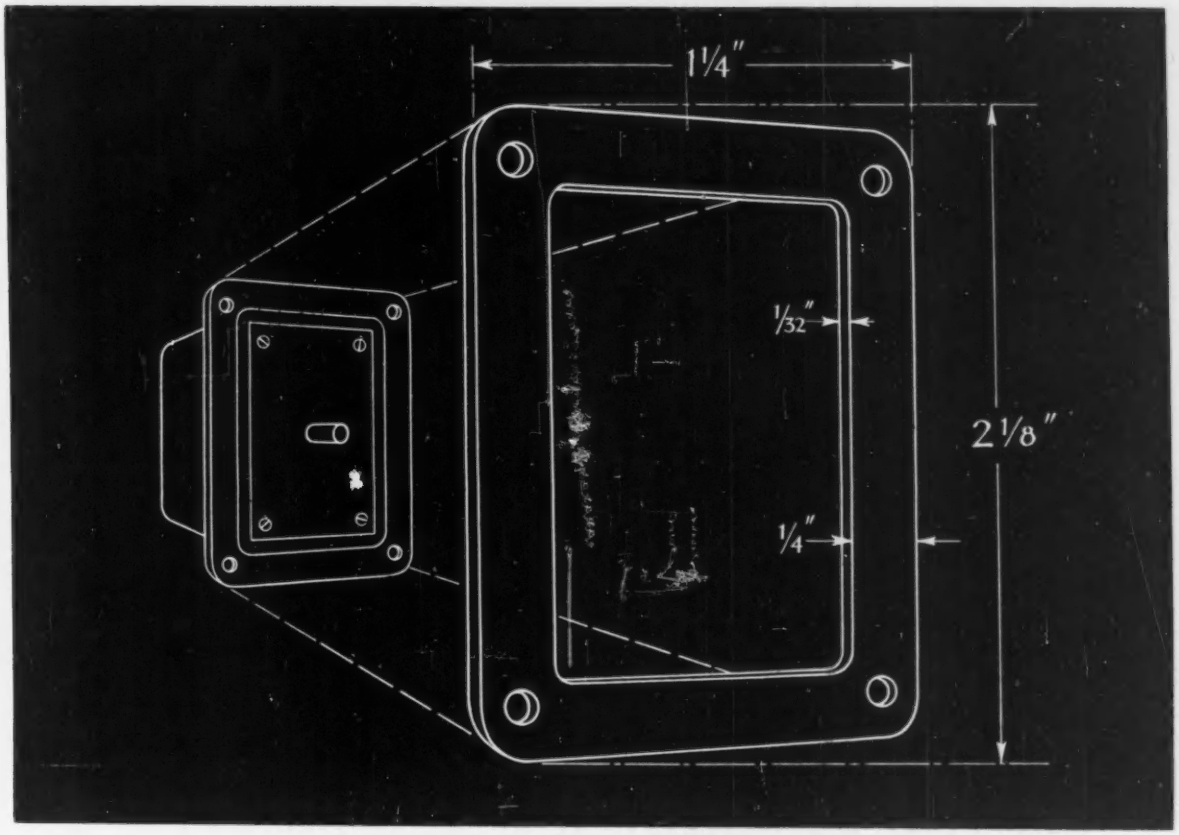
UNITED STATES STEEL



Here's a fiber gasket that seals under light bolt pressure

The stamped metal flange of this solenoid cover made sealing with conventional fiber gaskets difficult. Under light bolt pressure, which was all that could be used without distorting the flange, most fiber gaskets developed oil seepage.

The engineer in charge avoided the expense of a high-cost gasket by using an entirely different kind of fiber gasketing—Armstrong's Accopac®. This new material has the high, even compressibility needed for a positive seal under light flange pressure. Finely ground cork particles added to Accopac's fiber and latex composition give it this high compressibility and insure leak-free sealing.

Crush resistance. On rough, heavy cast flanges, Accopac seals equally well. It has unusual resistance to crushing, which often occurs when bolting pressures are concentrated at local high spots. Accopac withstands loads up to 100,000 psi without damage, while conventional fiber sheets often rupture at approximately 25,000 psi.

Won't shrink, won't grow. In use or in storage, Accopac gaskets maintain their unusual dimensional stability. Not even hot oil will cause them to shrink, dry out, or leak when used in any recommended application.

This dimensional stability helps reduce storage losses. Variations in temperature and humidity don't cause progressive or permanent changes in Accopac replacement gaskets. They'll still fit, still seal perfectly after many months in storage.

Write for samples. You may find Accopac helpful in replacing an unsatisfactory fiber gasket or in reducing costs on a gasket now made from a more expensive material. For samples, call your nearest Armstrong office or write us. Accopac is available in sheets, rolls, ribbons, or die-cut shapes, in either cellulose or asbestos types. Armstrong Cork Company, Industrial Div., 7006 Irvin Street, Lancaster, Penna.

ARMSTRONG'S ACCOPAC

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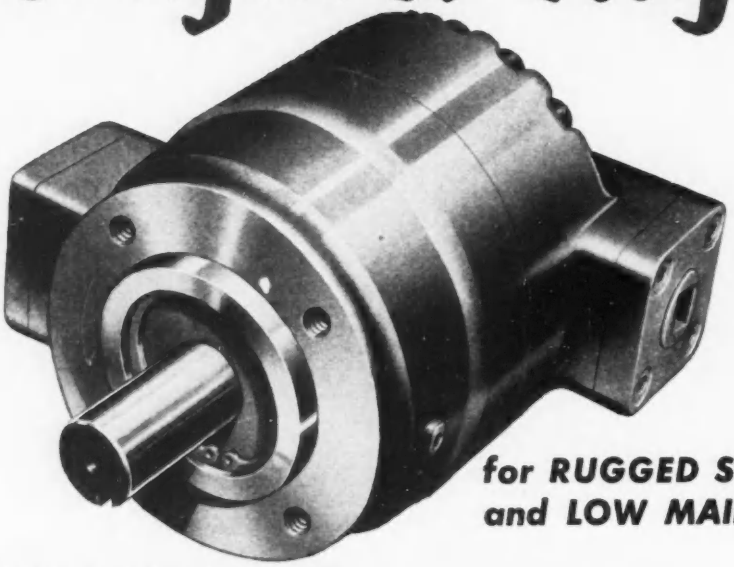

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For *Pump* or *Motor* duty at 2000 psi

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And you get it, in PUMP/MOTORS.

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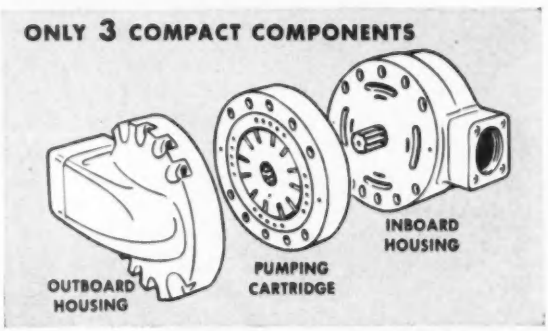
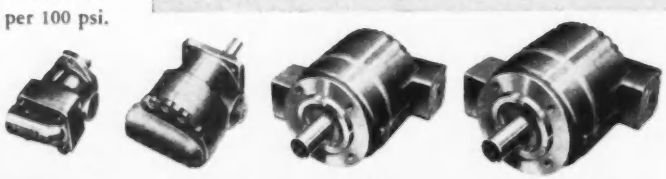
You'll be ahead by filling pump and motor needs in the 2000 psi range with the smooth, balanced action and built-in reliability of Denison's dual-use, bi-directional PUMP/MOTORS. *Write today for Bulletin P-5.*





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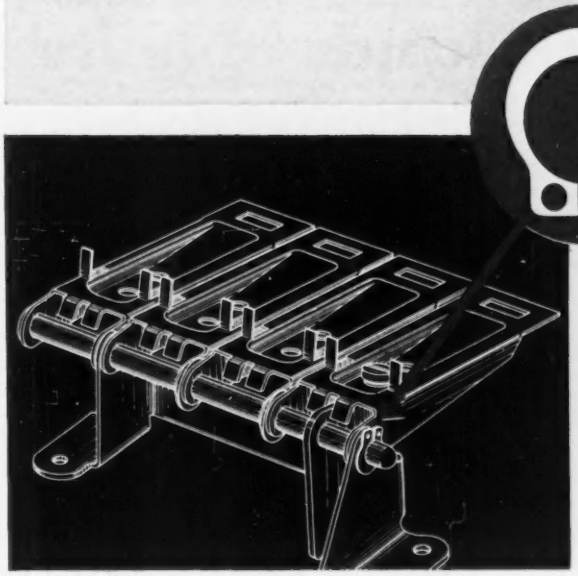

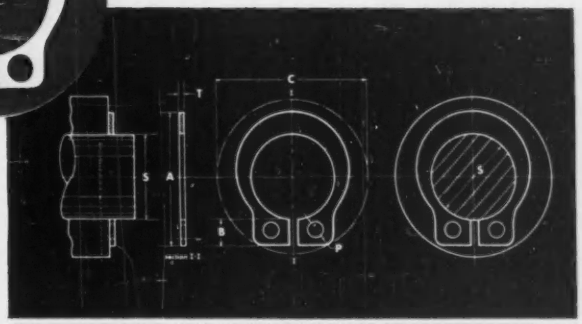

Ring # 5555		5555-12	5555-13½	5555-18	5555-25	5555-31	5555-37
SHAFT DIAMETER	Fract. Equiv. S	1/8"	—	3/16"	1/4"	5/16"	3/8"
	Dec. Equiv. S	.125	.136	.187	.250	.312	.375
	TOL.	±.002	±.002	±.002	±.002	±.003	±.003
RING DIMENSIONS	Thickness T	.025	.025	.035	.035	.042	.042
	TOL.	±.0015	±.0015	±.002	±.002	±.002	±.002
	Length A	.268	.285	.364	.437	.553	.626
	Lug B	.078	.078	.097	.097	.141	.141
	Hole P	.042	.042	.042	.042	.078	.078
	Min. Ring Clear C	.33	.34	.44	.50	.67	.73
Approx. Ultim. Thrust Load (Lbs)		20	20	25	35	50	60

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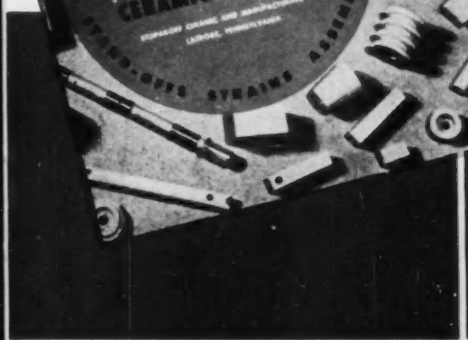

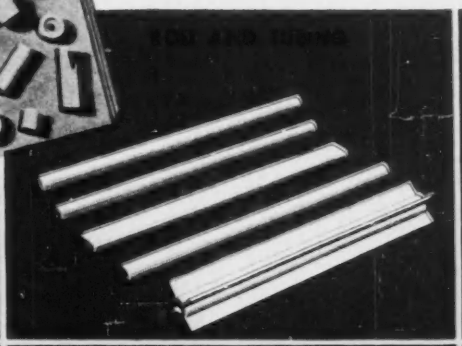

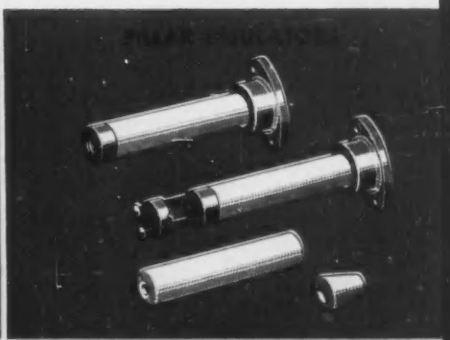

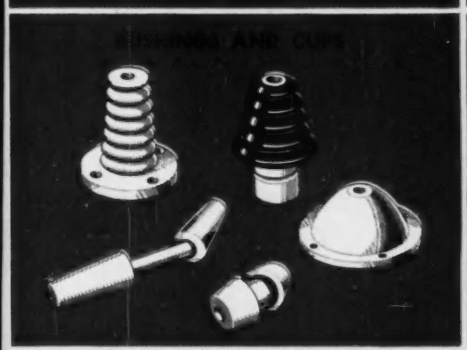

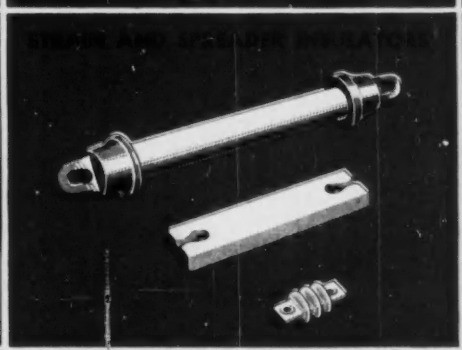

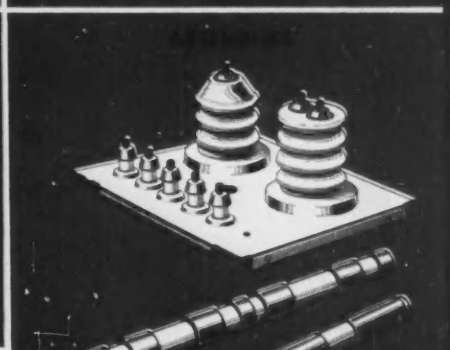

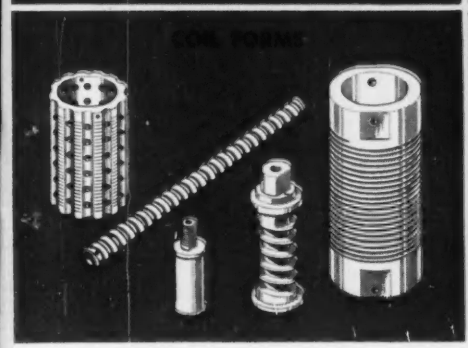

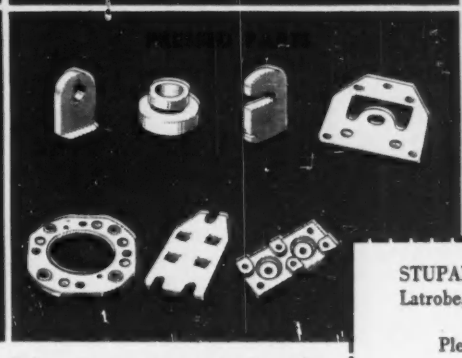

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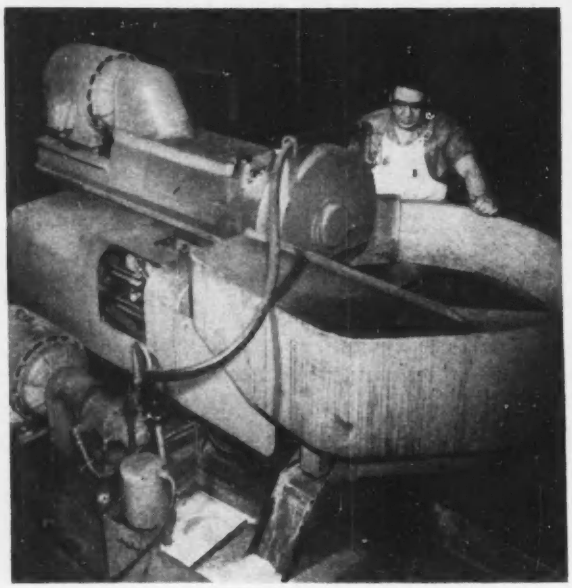
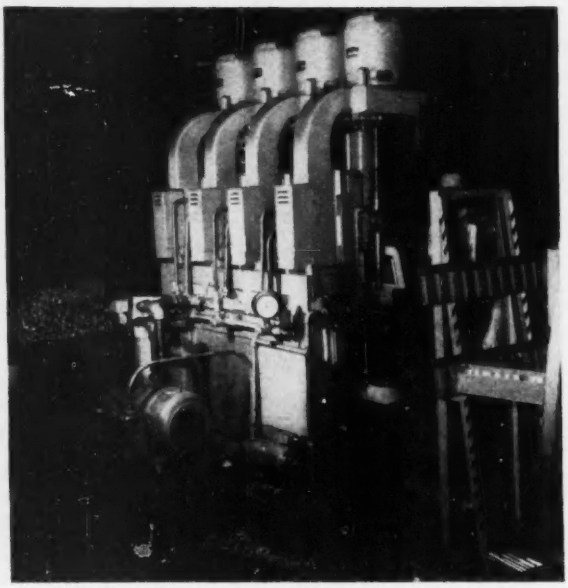
Designer's



IN DAMP, DIRTY ATMOSPHERES, G-E totally enclosed motors, as on this grinder job, need no special paints or other extras.



OIL, METALLIC DUST haven't damaged windings and bearings of this G-E totally enclosed motor even after many years of use.

Meet special design needs with standard G-E *TRI CLAD* totally enclosed motors

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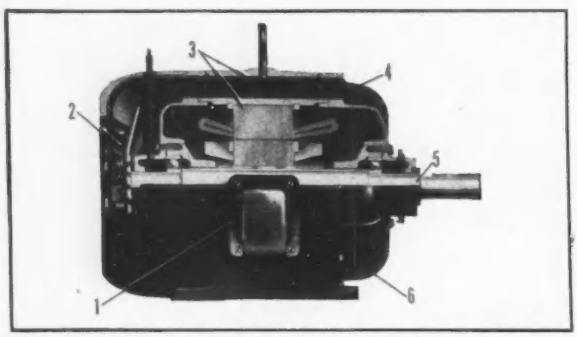


DESIGN FEATURES INCLUDE: **(1)** Sealed conduit box; **(2)** Non-sparking, non-corrosive fan; **(3)** Double-shell, cast-iron frame; **(4)** Non-clogging air passages; **(5)** Protective labyrinth seal; **(6)** Reinforced cast-iron end shield.

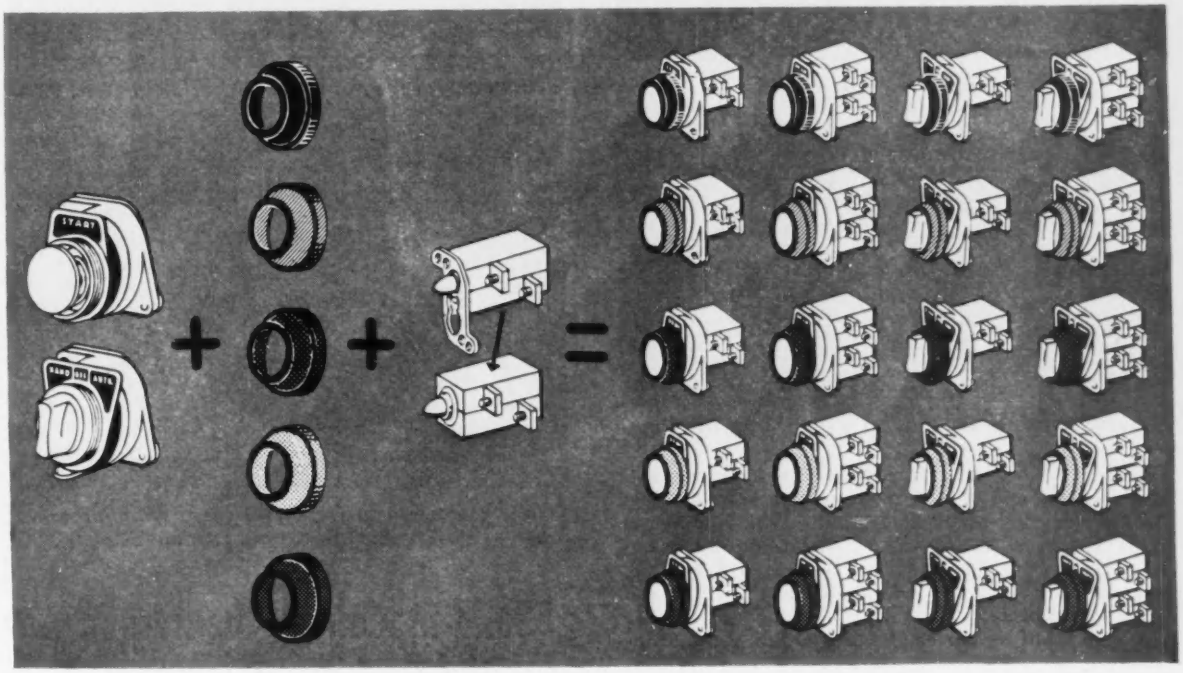
Extremely dusty, dirty and corrosive atmospheres need not call for a special-design motor. Specify, instead, an "off-the-shelf" G-E Tri-Clad totally enclosed motor for machines that must keep going under tough operating conditions. It has built-in extra protection against physical damage, electrical breakdown, and operating wear and tear. These extra-protection features are ***standard,*** and the motor—conforming to JIC "specs"—will operate successfully under the most adverse conditions without special paints, additional enclosures, or other "extras." Re-lubrication, when needed, is easy, even while motor is running. Because Tri-Clad motors are standard, ordering is simpler, shipment faster. Available ratings from 1 to 1000 hp For further information, write for Bulletin GEA-4400.

GENERAL ELECTRIC

Digest

MOTOR & CONTROL HIGHLIGHTS

Stock only 9 parts, get 20 combinations with new G-E oiltight push-button line



Extra flexibility cuts your inventory cost

Especially designed to meet the needs of machinery designers and manufacturers, General Electric's all-new oiltight push-button line brings you new "building-block" flexibility—for new savings in assembly time, inventory costs, and storage space. For example, by stocking only two operators, five color-coding rings, and two contact blocks, you make 20 different push-button unit combinations. Standard components include one basic type of contact block, five interchangeable color rings for coding, and a wide variety of interchangeable operators.

Unit components, units, enclosures, or complete stations are all available in this new, out-in-front G-E line. For more information, make a note to see your G-E Apparatus Sales representative, or send for new Bulletin GEA-5779.

General Electric Company
Apparatus Sales Division, Sec. C668-102
Schenectady 5, N. Y.

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Please send me the following bulletins:

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☐ **GEA-4400 Totally Enclosed Motors**
☐ **GEA-5779 Oil-tight Push-button Units**

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

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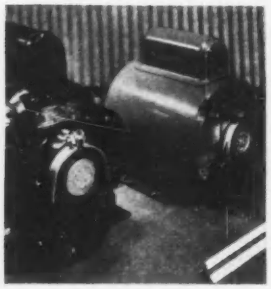
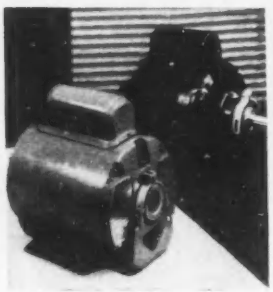
TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS

NEW G-E FHP MOTOR OFFERS FOUR BIG FEATURES TO IMPROVE YOUR PRODUCT



It's smaller . . .

lighter . . .



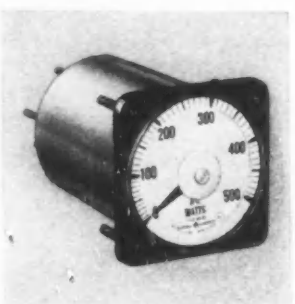
better looking . . .

more versatile!

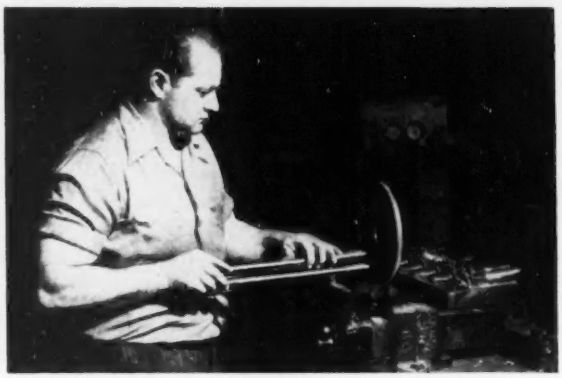
You'll find this completely new line of G-E Form G fractional-horsepower motors can help you design new and more saleable features into your product; can free you from former design limitations. Smaller size saves space on driven machines. Lighter weight cuts your shipping and handling costs. Its better appearance aids your product's sales appeal. And all-angle operation means this standard, general-purpose motor can often replace costly specials. For complete information, see Bulletin GEA-5567.

SHADOWS ELIMINATED ON NEW G-E LONG-SCALE SWITCHBOARD INSTRUMENTS

New G-E shadow-proof design means accurate readings, even under sharp-angle lighting. Also, small size reduces mounting problems. Available as ammeters, voltmeters, and watt-meters, for either a-c or d-c. The AB-, DB-16 types feature an eight-inch diameter scale. The AB-, DB-18 types have a four-inch diameter scale. All are accurate within ± 1% of full scale. Check Bulletin GEC-218.



***"Require less space, cut fabrication costs,"** says one oven manufacturer of the fin Calrod heaters he uses.*



Calrod immersion heaters give these hospital sterilizers precision heat, withstand continuous wear.

Build-in Calrod* heaters . . . reliable, accurate, compact

When your products need clean, accurate, easily controlled heat, build-in General Electric Calrod heaters. Reliable, compact, and convenient, these heaters are quickly installed, require practically no maintenance.

Whatever machines *you* build that need a "spot" or "zone" of heat—packaging, textile, printing, bottling, labeling, or extrusion machines—there's an economical Calrod heater for the application. The full line includes immersion, strip, cartridge, tubular, and unit and fin heaters. See new illustrated 16-page Bulletin GEA-5866. It shows how 18 machinery manufacturers use Calrod heaters to improve their products. Check coupon at right for your copy.

**Reg. trade-mark of General Electric Company*

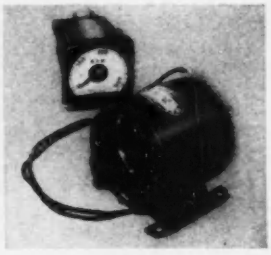
GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS

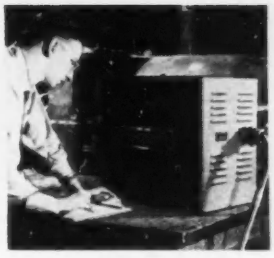
WIDE G-E TACHOMETER LINE PERMITS MEASURING RPM OF ANY MACHINE

Hand



Electric

Electronic

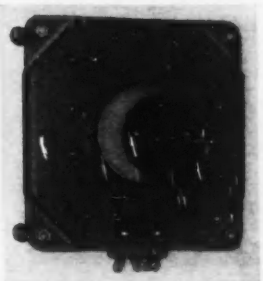


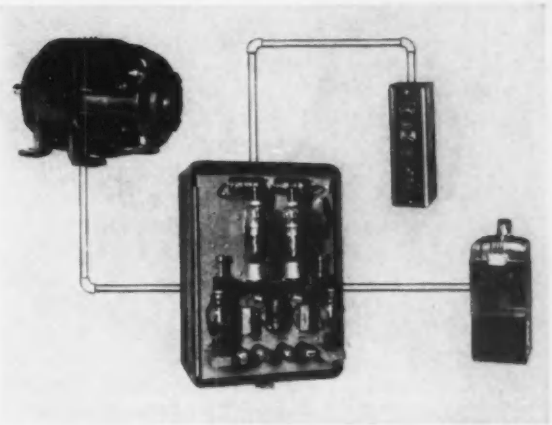
Special

Protect your product's quality from harmful changes in machine speed with one of these four G-E tachometer equipments. Use them, too, for checking the efficiency of your high-speed machines—to save fuel costs and save maintenance time. Accuracies vary from ±1 per cent to 0.025 per cent, covering ranges from 0 to 400,000 rpm. For full information, check appropriate bulletin in coupon.

EASY-TO-MOUNT PLATE RHEOSTATS GIVE CLOSE D-C SPEED CONTROL

For accurate d-c motor speed control, specify these G-E plate-type field rheostats. Four-point mounting eliminates need for additional feet or brackets. Adjustable stops at each end of travel, give added flexibility. Three sizes: 12-inch with 70 resistance steps, 9-inch with 52 steps, 6-inch with 27 steps. See Bulletin GEC-487.





Now—a simplified, smaller G-E adjustable-speed drive

All the basic features of General Electric's Thy-mo-trol* adjustable-speed drive—smooth, stepless speed control, pre-set speed control, and close speed regulation—are included in this new, lower-cost, standardized model. Simplified, space-saving electronic control panel (also supplied in open form) is half the size of more elaborate types. In reversing and non-reversing forms, ratings are ¾, 1, 1½, 2, and 3 hp, in speed ranges of 5:1 and 20:1 (1750/350 rpm and 1750/88 rpm.)

For complete data on the ¾ to 3 hp drive—part of the full Thy-mo-trol line ranging from 1/40 to 75 hp—see Bulletin GEA-5829.

General Electric Company,
Apparatus Sales Division, Sect. C668-103
Schenectady 5, N. Y.

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Please send me the following bulletins:

√ for reference purposes X for immediate projects

- ☐ GEA-4324 Electric tachometers
- ☐ GEA-5567 Fhp motors
- ☐ GEA-5829 ¾—3 hp Thy-mo-trol
- ☐ GEA-5866 Calrod heaters
- ☐ GEC-218 Switchboard instruments
- ☐ GEC-224 Electronic tachometers
- ☐ GEC-241 Hand tachometers
- ☐ GEC-487 Plate rheostats
- ☐ GEC-560 Special tachometers

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

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Job costs ARE FIGURED ON A SQUARE FOOT BASIS

WHILE material IS PURCHASED ON A WEIGHT BASIS

18 gauge x 36"x120"
=63.00 lbs. (theoretical)

Here's how *MicroRold* Stainless Steel SAVES you money

In the use of stainless steel, the selection of gauge number is usually determined by the minimum permissible thickness having sufficient strength to meet the requirements of the application. When you receive material on the heavy side of the gauge you are paying a premium for stainless surface area.

When sheets are ordered by gauge number, the permissible A. I. S. I. variation in thickness is plus or minus 10%. Thus, if you order 18 gauge, you may receive sheets .052" thick, when a thickness of .0475" would suit your purpose. Using a standard 18 gauge 36" x 120" sheet as an example, the theoretical weight is 63.00 pounds, but this weight could permissibly vary between 59.22 pounds and 65.52 pounds. Each .001" of thickness adds 1.26 pounds per sheet.

MicroRold sheets may be ordered by gauge number and you can specify they be rolled on the light side of the gauge range. This is true because the equipment is such that more accurate control of thickness is possible.

If you are not a user of MicroRold sheet it will pay you to get the full details. Your steel warehouse distributor will gladly tell you the MicroRold story.

Washington Steel

CORPORATION

WASHINGTON, PENNSYLVANIA

Perspectives ~ DESIGN AND DEVELOPMENT

BASIC RESEARCH

Despite the large amounts of money being earmarked for research by private industry and government agencies, so little is filtering into basic research that we are using up fundamental knowledge much faster than it is being repleted. That was the consensus of five of the nation's top research administrators when they met recently in Washington to discuss the future of fundamental research before the Chemical Engineer's Club.

Not only should our engineering and scientific personnel be gravely concerned, but industrial, military and government leaders as well - if the opinions of the researchers are of any value. They should be. They came from such men as Dr. Merle Tuve, Director of the Division of Terrestrial Magnetism at the Carnegie Institute of Washington; Dr. Mervin J. Kelly, President of Bell Telephone Laboratories; Dr. Julius A. Stratton, Vice-President and Provost of the Massachusetts Institute of Technology; Dr. Alan T. Waterman, Director of the National Science Foundation; and Dr. Vannevar Bush, Director of the Carnegie Institution.

EUROPEANS AHEAD

In the past we have been depending on Europe for our fundamental research. Our atomic energy work, rockets, guided missiles, jet planes, penicillin, DDT, and scores of other important developments have stemmed from European investigations.

During World War II we dipped into the inventory of European basic research and our own on an emergency basis. Many basic ideas were rushed into practical form ahead of time. This left just a little "starter" material to continue the fermentation after the war. The problem we face now is to increase the amount of material in the pot and this won't be an easy job. The probability of success in basic research is much less than with applied or developmental programs. Some researchers feel that 10 percent if the programs succeed, that's good.

MORE MONEY NEEDED

More money would provide the answer, but this money would have to come from industry and government because endowments of universities, where the major basic research work is under way, are falling. Figures collected by the National Science Foundation show that of the Federal Government's $2-billion research program, only $140-million goes for basic research. Biggest chunk -- $1.2-billion -- goes into developmental research and about $800,000,000 goes into applied.

But even now, this industry and government support of basic research at universities is causing some apprehension. The character of the university is changing as a result of the large-scale projects that are being carried on. But these are primarily applied or development research projects, and result not only in greater government influence in the colleges but in a dissociation of research and teaching -- one of the factors that has contributed to a strong faculty in the past.

OTHER ANSWERS

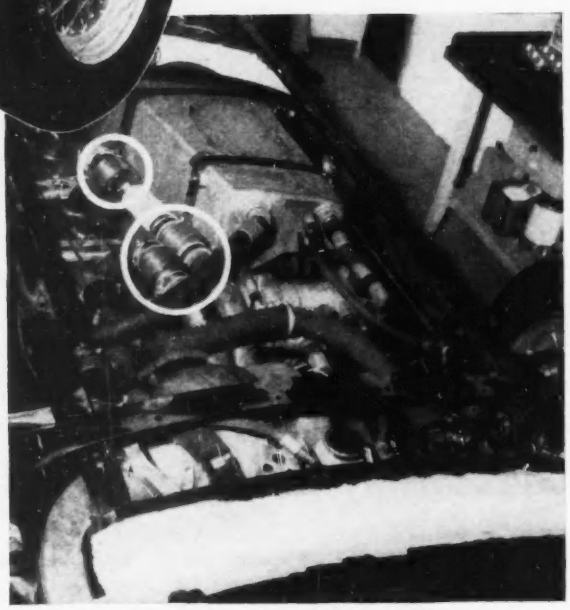
Other answers are not easy to come by, but two that currently are being studied have some promise: (1) encouragement of private industry to invest more in basic research -- such encouragement to take the form of tax benefits in some form or another; and (2) fewer development research grants to universities, which because of its negative character, might force these institutions back into the paths of more basic studies.

(Continued on page 135)

CMH REX-FLEX *Stainless Steel* Hose...

The three sections of REX-FLEX hose circled at the right passed one of the most severe tests to which flexible metal hose can be put. They successfully withstood the heat and vibration of the exhaust line of the Cummins Diesel Special as it captured the coveted pole position at the 1952 Indianapolis 500 mile race with a speed of 138.010 mph. for the 10 mile qualifying run.

Performance like this is your best assurance that CMH REX-FLEX will do the job whenever liquids or gases must be conveyed under conditions of vibration, flexation, misalignment, expansion and contraction, corrosion or temperature extremes. CMH REX-FLEX is available in sizes from 5/16" to 6" I.D. braid covered or unbraided. It is suitable for burst pressures to 24,000 psi, temperatures to 1600° F. Write for descriptive literature or see the Flexonics catalog in Sweet's File for Product Designers.



CHICAGO METAL HOSE Division

Flexonics *Corporation* 1351 South Third Avenue, Maywood, Illinois

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies CMH products that have served industry for over 50 years.

CMH

Flexible metal hose

Expansion joints

Aircraft components

Metallic bellows

RESEARCH MANPOWER

It is also important to get more people into research, but first something has to be done about getting more students to take engineering and the sciences at the universities. Bad preparation by high schools, and better financial rewards in other work are chiefly responsible for the present squeeze.

Our output of BA's from colleges in 1954 will be less than half of the 1950 figure, and will not go up until about 1956. At the same time, Russia's output keeps climbing. Last year Russia is reported as having passed the U. S. in output of BS's and -- according to Dr. Waterman -- by 1954 the Soviets will be turning out twice as many college graduates as the United States.

NOSE COUNT

Right now the government is taking another stab at the problem of counting noses and keeping track of the nation's scientific people. This time, there's a new approach. The effort will be cooperative with professional societies, not merely a government operation.

A new office, set-up under the direction of the National Science Foundation, is to help the societies in compiling their data. It will set rough guidelines for the work and encourage the societies to use uniform methods of collecting information. A financial incentive is proposed. The societies would get a grant every year to carry on the work, in return for which the NSF would get duplicate cards and records and summaries of information. The NSF's Scientific Manpower Section is now "talking" with professional groups about the type of grant or contract that may be worked out to help them finance their operations.

Because Congress had cut the NSF budget below the "Eisenhower Budget" and way below the "Truman Budget", the NSF is off to a rather slow start. But the skeleton of the organization and theory of operation has been decided.

THE PROGRAM

NSF has established a fourpoint program:

1. To provide standby machinery for identifying and locating persons with special skills on short notice in the event that in an emergency such machinery becomes necessary to the national security.
2. To assemble statistical information on the supply, training and utilization of scientific and engineering personnel.
3. To assemble comparable statistical information on the demand for such personnel.
4. To provide an information center through which information about scientific and technical personnel resources may be funneled to those who seek it.

If you're a professional man in science or engineering, you'll get the questionnaire to fill out later this year.

The new questionnaire form will have only half the number of questions as the one used during World War II: Name, address, age, sex, highest degree attained, from what university, in what field, and when, present employer, duties, years of professional experience, and citizenship.

COOPERATION IMPERATIVE

To do the job NSF will need the cooperation of everyone involved. One of the consultants on this problem, Philip N. Powers, Executive Administrator of Monsanto Chemical Company's atomic electric project, said that NSF can meet the heavy responsibility given it by the Congress only with the wholehearted assistance and guidance of the scientific community itself.

He feels this is one of the most important jobs that Congress has given to NSF, "For through proper use of facts about these manpower resources lies the promise of making the best possible use of our scientific and engineering brainpower to give greatest strength to our country."

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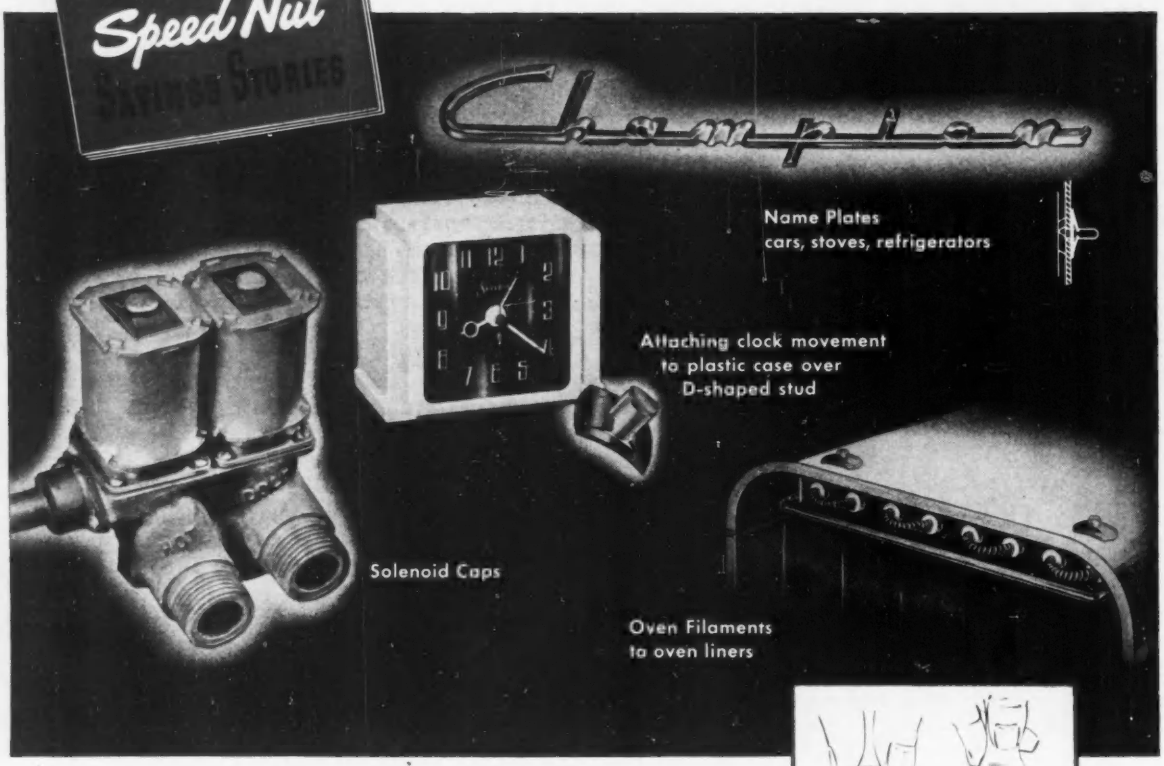
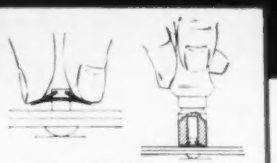
Champion



NEW Tinnerman Push-On SPEED NUTS®
...for wide range of applications
– PRICE SAVINGS AVERAGE 25%!

● Tinnerman, originators of Push-On type SPEED NUTS, offers this new C12000 Series at substantial savings! Large volume, high speed production, plus years of engineering and manufacturing experience make this economy possible! These new lightning-fast Push-Ons are available in a complete range of popular sizes, with rust-resistant finish, for round, D-shaped or rectangular studs. A unique feature, exclusive with Tinnerman Push-Ons, is their use over D-shaped studs where removability is desired.

Call or see your Tinnerman representative for full, cost-saving information about these new, low-priced Push-On type SPEED NUT brand fasteners.



NEW C12000 Push-On
SPEED NUTS

...are one-piece, self-locking, spring steel fasteners. Start by hand...zip down over integral studs, rivets, tubing, nails, any unthreaded parts; bite lock on smoothest, hardest surface!

Send today for copy of "Greater Savings Than Ever with C12000's"; also FREE Production Samples! Write: TINNERMAN PRODUCTS, INC., Dept. 12, Box 6688, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A. – 7 rue Henri Barbusse, Levallois (Seine).

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MORE THAN 8000 SHAPES AND SIZES

Smug Engineering Societies

THE DISMISSAL OF DR. ALLEN V. ASTIN, Head of the Bureau of Standards by Sinclair Weeks, Secretary of Commerce was a sorry affair. The reasons given for the dismissal smack strongly of the kind of politics which the majority of the electorate voted out of office only a few months ago. Mr. Week's hasty retreat leads one to conclude that he decided he had made a bad mistake.

Even more deplorable than the dismissal of Dr. Astin is the failure of our large national engineering societies to take any announced stand on the matter or in any way protest the action taken by Mr. Weeks. A number of scientific societies did take prompt action.

There is now being formed a committee of engineers and scientists, at the instigation of the Secretary of Commerce, to investigate not Dr. Astin's dismissal but rather the operation of the Bureau of Standards, particularly with reference to its administrative procedures. Presumably such an investigation and report will effectively erase the possibility of any other investigation by the same or similar committee relating to the Astin affair. Also, such a committee could not very well make recommendations to limit the power of the Secretary of Commerce to fire the Head of the Bureau of Standards.

The position of Head of the Bureau of Standards should be a career job subject to dismissal only for certain defined reasons or perhaps only after a hearing before a body of scientists selected on the basis of the positions they occupy.

It would be extremely regrettable if our national engineering societies, including specifically the ASME and the AIEE, appoint official representatives to serve on the committee, and then have the power of the committee so extremely limited that it can come up with no findings other than innocuous ones that would exonerate the Secretary of Commerce of any blame or fault in the Astin affair or ignore that matter entirely.

It is most regrettable that these great national engineering societies have repeatedly demonstrated that they will not take any position of leadership concerning national affairs that are basically science and engineering and that will have a tremendous effect both upon the profession and the public. As one of the junior officers of the ASME put it, "The ASME traditionally stays clear of anything smacking of politics on any level, be it state or national."

It is high time that the Council of The American Society of Mechanical Engineers realizes that times have changed and that the society can no longer refuse to acknowledge its responsibilities in public affairs. With the tremendous strides being made in science, engineering and industry, it is becoming more and more important that there be technological leadership to preserve and further the professional status of engineering and to exercise a dominating influence to protect the public against exploitation, direct or indirect, by charlatans and politically inspired bureaucrats.

Here is a great opportunity for the younger members of the national engineering societies. They would do a tremendously valuable service to their profession if they organized to bring about an awakening of their fellow members to their new responsibilities in this advanced age. The present impotence of our national societies in matters of public concern invites the formation of competing societies.

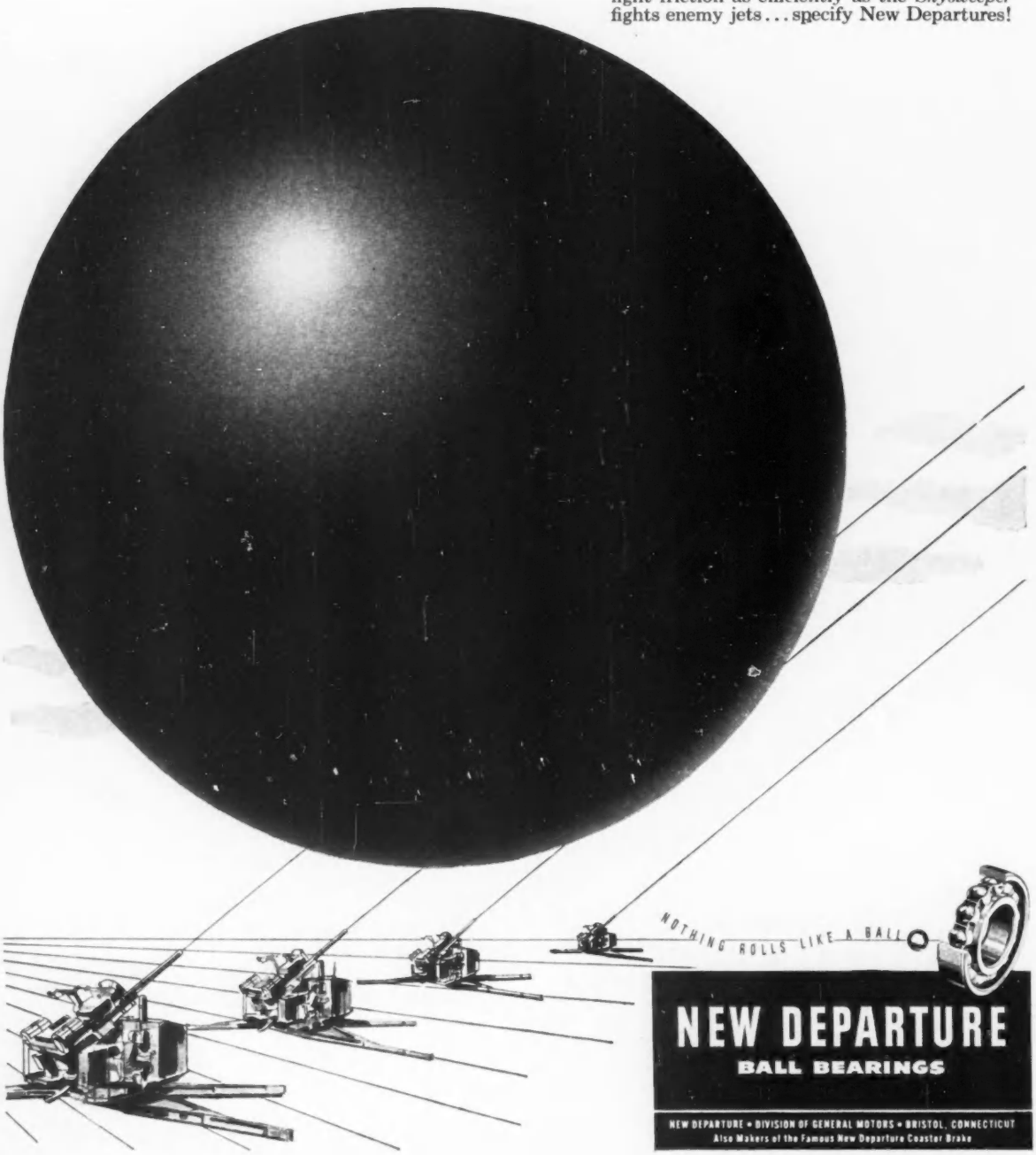
George F. Bodenholt

SKYSWEEPER -ACCURATE TO THE ND DEGREE

This wonder weapon can detect an approaching enemy aircraft 15 miles (90 seconds) away and blast it out of the sky. The *Skysweeper* automatically gauges the speed and course of the oncoming target and fires proximity-fused shells to bring down the plane.

Precision-made New Departure ball bearings help give the *Skysweeper* its uncanny ability to detect and destroy. These instrument bearings are marvels of accuracy themselves. All component parts must pass countless inspections . . . meet the highest manufacturing standards in the industry.

In all applications, specify bearings that fight friction as efficiently as the *Skysweeper* fights enemy jets . . . specify New Departures!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NEW DEPARTURE
BALL BEARINGS
NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
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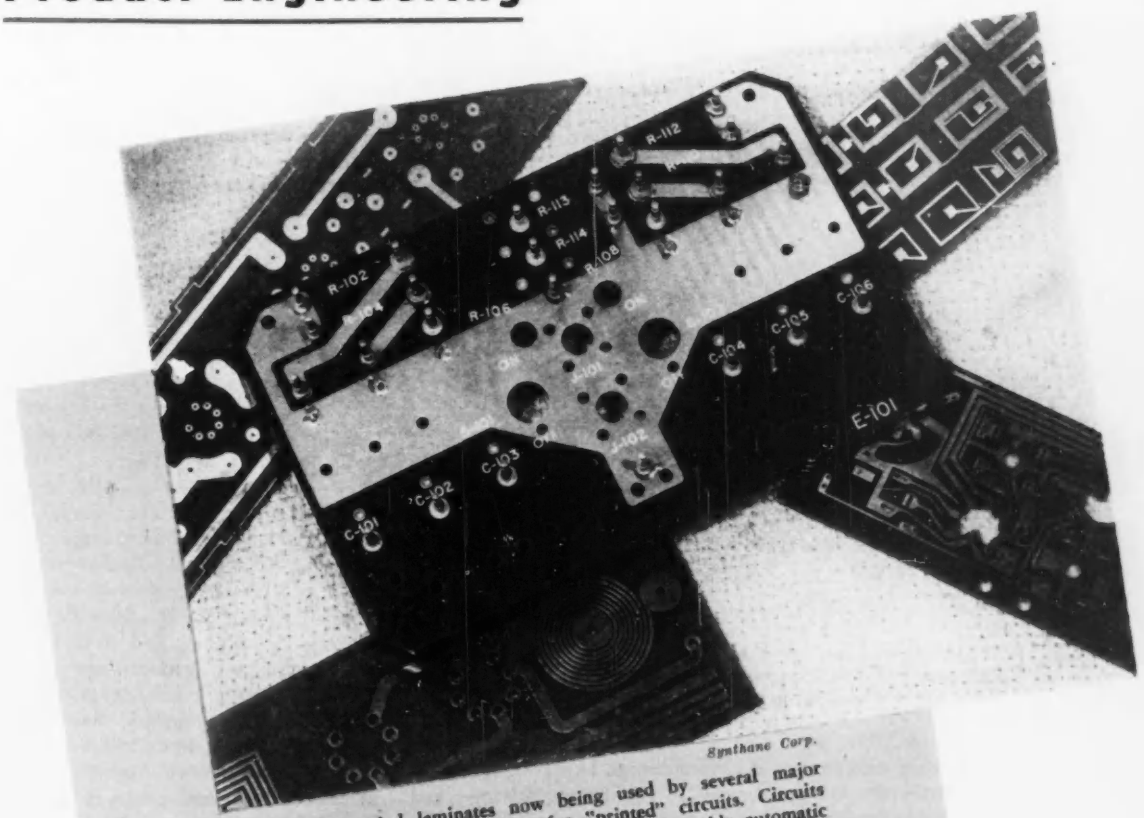


Synthane Corp.

Fig. 1—Copper clad laminates now being used by several major radio and television manufacturers for "printed" circuits. Circuits etched on such laminates are also adaptable to hearing aids, automatic signalling devices, electronic computers, and telephone equipment.

New Engineering Materials

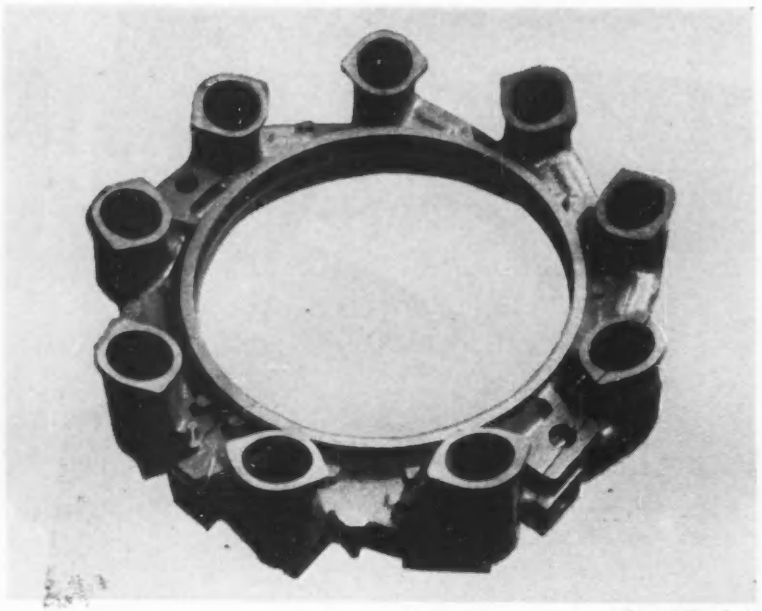
Following are developments in engineering materials that are being or soon will be incorporated into products now on drawing boards. Many will be featured at the First Exposition of Basic Materials being held in New York June 15 to 19. Others have only recently become commercially available.

POWDER METAL

RECENT WORK on molding of controlled porosity parts may well point the way to a much wider application of powder metallurgy, according to competent industry observers. This work has been concentrated on sweat and transpiration cooling of aircraft engine components—the forcing of liquids or air, respectively, through porous metal parts operating at elevated temperatures.

Results of these investigations can be applied widely. Use of a plastic binder, mixed with the metal powder, can be used to obtain close control of porosity, since the binder is volatilized on sintering; binders have been developed that leave little or no residue.

Better molding techniques permit



Howard Foundaries

Fig. 2—Pressure tight magnesium compressor case casting. Over 50 in. in diameter and weighing approximately 130 lb, this part must be held to close dimensional tolerances, represents specialized control.

the fabricator to regulate porosity not only through a cross section but along the length of a part. Several pressings are sometimes made on the same compact, with material being added to increase compacting pressures at strategic locations where high density and thus high strength are required.

CASTINGS

All of the casting methods, from sand to permanent mold, have received considerable attention within the past year. Size has been emphasized in investment and permanent mold castings, with the former being made from injection molded polystyrene patterns in weights up to 35 lb. Light pressure on the metal prevents porosity and insures uniform density.

Die castings are also due to get substantially bigger, with one machine now being built to handle a single shot of 75 lb of aluminum. Not much progress has been made toward a higher temperature die material that would insure longer die life and thus lower cost magnesium castings, but at least one producer feels that molybdenum base alloys will eventually solve the problem.

In sand casting, ductile iron and some of the Meehanite alloys are giving the industry a shot in the arm. And according to Howard Foundaries, increasing rigid engineering and metallurgical specifications for castings have caused foundries to develop new and highly specialized control facilities. This is particularly true of the newer alloys such as ductile iron and those of magnesium. Foundries are being asked to cast intricate castings in tolerances that a few years ago would have been considered impossible. The magnesium compressor case casting, Fig. 2, with its cast-in stainless steel blades is an example of what foundries are doing. Today, however, relatively few foundries are qualified to cast this intricate piece because completely rigid control facilities are lacking. To successfully cast this piece as well as the ductile iron casting, rigid control of every step in development is necessary. Most progressive foundries feel that control laboratories and casting facilities will be under one roof in the near future, thus insuring both dimensional accuracy and close composition and grain control.

TUBING

In metal tubing, the story is from lightweight to heavyweight, from small size to large. Take the case of one producer, Superior Tube Company.

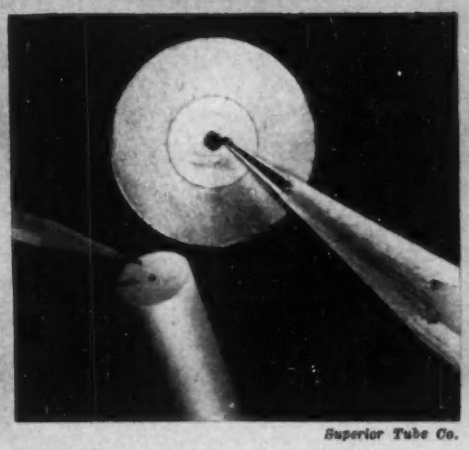
Superior lists their products these days under the following types: hypodermic needle, bourbon, hydraulic, super pressure, micro-precision, mechanical, and special shaped. The super pressure grade will withstand internal pressure of from 25,000 to 200,000 psi, Fig. 3, and is finding application in homogenation and polymarization processes in the chemical and oil refining industries. Seamless lightweight tubing, in wall thicknesses from 0.010 to 0.025 in., Fig. 4, and in standard grades, three grades of stainless, and Monel, is expected to find use where pressure limits exceed the allowables for welded tubing.

Commercially pure and alloy titanium tubing also is being drawn—in development samples of commercially pure metal down to 0.0455 in. OD and wall thicknesses of 0.00225 in. At present, this small size tubing is used for experimental work in the electrical, electronic and chemical industries. Standard sizes—from $\frac{1}{8}$ to $1\frac{1}{2}$ in. OD with wall thicknesses from 0.004 to 0.187 in.—already are in commercial use in the processing,

Table I—Sizes and Service Conditions for Glass Pipe[1]

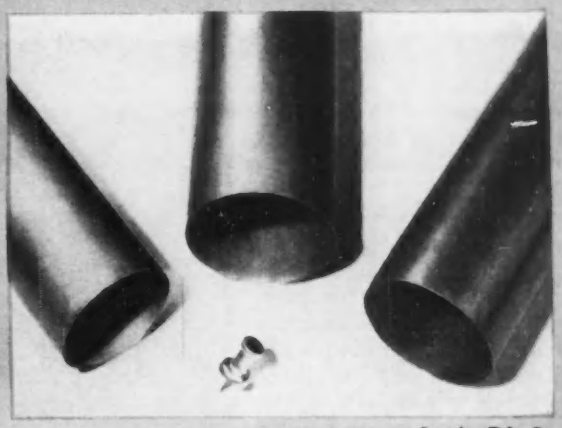
Pipe Size, in	Max. Recommended Working Pressure, psi	Max. Sudden Temperature Differential, F	Max. Operating Temperatures*
1	50	200	450
$1\frac{1}{2}$	50	200	450
2	50	200	450
3	50	200	450
4	35	175	450
6	20	160	450

[1] Pyrex type, Corning Glass Works.
* Glass must be insulated or protected so that maximum sudden temperature differential values are not exceeded.



Superior Tube Co.

Fig. 3—Super pressure tubing, made from two thinner-walled tubes that are drawn over each other.



Superior Tube Co.

Fig. 4—New large sizes of seamless light-wall tubing. Maximum O.D. in the seamless grade is now over 2 in.

pharmaceutical, and aircraft industries, where its lightweight, high strength, and excellent corrosion resistance show to particular advantage.

In the piping field, non-metallic materials such as glass and plastic are moving not only into the processing industries, but in the case of plastic, on shipboard. The advantage of glass is that it is impervious to attack by any acid except hydrofluoric and, according to Corning, Pyrex pipe will hold up under the conditions listed in Table I.

Plastic pipe of the extruded type is also highly corrosion resistant, but not to the same extent as glass. Reinforced glass fibre types with a phenolic binder for marine or processing industry applications have a high strength-weight ratio, Tables II and III.

TITANIUM

With the announcement that the Crane Co. has obtained a DPC loan to construct a titanium reduction plant, the U. S. soon will have three primary producers of sponge, the other two: DuPont in Wilmington and Titanium Metals Corp. in Henderson, Nevada. The latter has been having production difficulties and still is not operating at rated capacity of 10 T/day.

All plants are or will operate on a modified Kroll process, although research is still under way on faster and cheaper methods of reduction. However, from current indications, improvements in the Kroll process may be so rapid as to circumvent such other methods as may be developed.

The chemical process of Horizons, Inc. is sitting on the shelf. It looks practical, has proven out in small scale operation, but requires a considerable investment to check through the pilot plant stage. This money Horizons does not have—and other firms are unwilling to put up without same patent protection or royalty free arrangement.

Insofar as the metal is concerned, progress has been rapid in commercially pure metal. Methods of fabrication and military uses have been well worked out. All fabricators have a backlog of orders; the stockpile which existed about a year ago has been eaten up by military demand.

But the picture is as gloomy on the alloy side as it is bright in pure metal. Alloys are still difficult to roll and fabricate, and while high in strength, are quite brittle.

ULTRA THIN METALS

The fields for thin metals, from precious metals to stainless steel, from carbon strip to ferromagnetic alloys, have broken wide open with greater availability. Many of the uses are in electrical and electronic devices, and in the aircraft industry.

American Silver Co., for example, is rolling aluminum, copper and copper alloys, nickel base alloys, precious metals, molybdenum, ferrous metal and

Table II—Size and Weight of Plastic Pipe[1]

O.D. in.	Wall Thickness, in.	Weight, lbs. per ft
4	0.125	0.97
6	0.188	2.15
8	0.250	3.88
10	0.313	6.07

Table III—Mechanical Properties of Plastic Pipe

Tensile strength	16,000 psi
Compressive strength	22,000 psi
Flexural strength	38,000 psi
Modulus of Elasticity	2.5
Impact (Izod)	15 ft/lbs per in. of notch

[1] Reflin Company.

others in widths up to 8 in. and thicknesses down to 0.0005 in. for pressure disks and diaphrams, low torque potentiometers, fulcrum springs, skin stock, decorative trim, and other applications. Tolerances as close as ±0.0002 in. are held on strip thicknesses from 0.010 to 0.006 in.; and ±0.0001 in. on thicknesses below 0.006 inches.

Carbon steel strip down to 0.0015 in. and stainless steel down to 0.002 in. is being produced by Rodney Manufacturing Corp. for somewhat different applications—some for decorative trim and cladding. This concern also is prepainting steel strip with baked enamel which is sufficiently flexible to permit blanking, stamping and cold roll forming operations without cracking or marring.

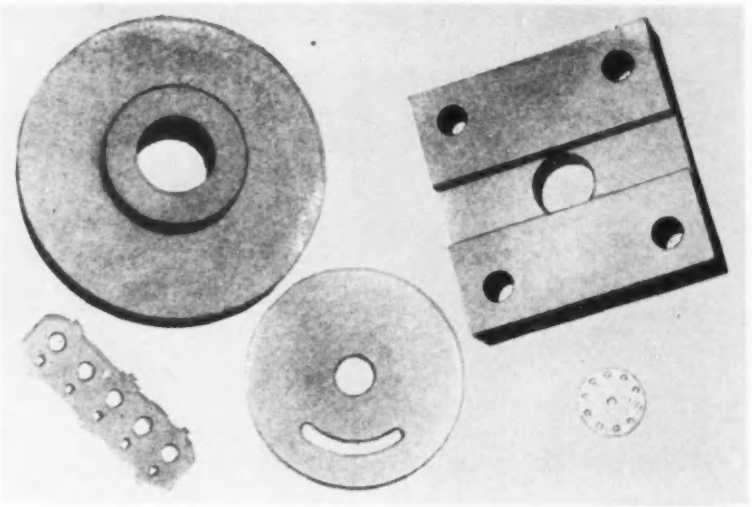
Finally, the ultra thin magnetic materials, such as Permalloy and Deltamax are being rolled in production down to ½ mil thickness, and experimentally have been reduced to 0.0001 in. by the Arnold Engineering Division of Alleghany Ludlum for peaking transformers, coils, and other components operating in the 100 KC frequency range. Core losses in these materials are a function of thickness: the thinner the metal, the lower the losses. Thus, they supplement the normal metal coils in the intermediate frequency range, but will not replace ferrites in the higher frequencies.

RUBBER

Perhaps the greatest strides in this field have been taken by companies outside the rubber industry—Chrysler Corp. and Westinghouse, for example, in cooperation with the ASA—in standardizing specifications. Idea stimulating this move is to establish industry requirements for different grades, let the supplier meet them with his own compositions. Formerly, specification by composition often left much to be desired, particularly since rubber and rubber-resin chemistry has reached such a complex plane as to be incomprehensible to the average engineer writing specifications.

For example, the American Hard Rubber Company has a new formulation which is said to have better rigidity, heat resistance, and chemical resistance than nitrile rubbers heretofore available. A thermosetting material that is available as pipe and fittings, molded products; sheet, rod, and tube; and as large hand formed fittings, it resists nearly as many inorganic corrosives as natural hard rubber, and in addition, it is resistant to many organic chemicals which attack natural hard rubber, soft rubber, and plastics. For instance, at room temperature it resists aliphatic hydrocarbons such as hexane, hexene, and other solvents such as ether, benzene, carbon tetrachloride, ethyl acetate, and benzaldehyde. It is resistant to oils. It is not recommended for sodium hypochlorite or for strong oxidizing agents such as nitric acid.

The tentative standards do not cover sponge rubber, which also is available in a number of different grades, including silicon base foam rubber for gasketing, sealing, dust proofing, shock absorbing, and sound and vibration damping in processing equipment or wherever extremes of heat and cold bar standard grades. These, like other grades, are available in sheet, die cut shapes, cord tubing and strips, molded forms, and pad stocks from such concerns as the Sponge Rubber Products Company.



Synthane Corp.

Fig. 5—Glass mat melamine laminate, combining high fire and arc resistance with good mechanical and electrical properties was developed for the Navy.

LAMINATED PLASTICS

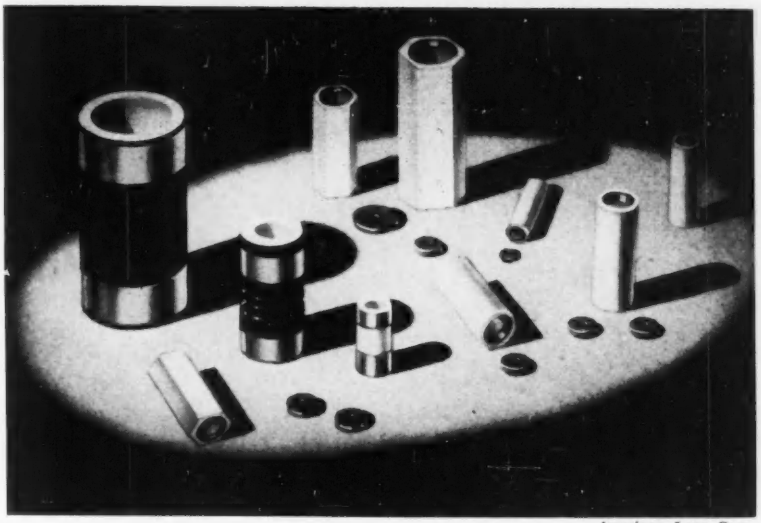
Manufacturers of thermosetting laminated plastic materials and fabricated products are moving in two directions—toward parts of much greater complexity, and toward laminates designed specifically to withstand specific operating conditions, with, for example, a cotton, glass, nylon, asbestos fiber, or paper base, and a variety of synthetic resin binders.

The Synthane Corporation has:

Metal Clad Laminates—Developed to standardize and simplify the production of electronic equipment through "printed" circuits.

Glass Mat Laminate—A new grade of laminate which combines high fire and arc resistance is being manufactured for the U. S. Navy's Bureau of Ships. Designated by Synthane as Grade G-8, the new laminate, Fig. 5, is also available to suppliers of electrical and power equipment under the cost of ordinary continuous filament glass-base material. In addition to electrical applications, the new laminate is expected to be particularly useful for parts where chemical resistance is required, such as in the plating and photographic industries.

Flame-Retardent Laminate—This material will not support combustion and provides increased safety by reducing afterglow effects. The new laminate is expected to find widespread applications in electronic or electrical applications where high ambient temperatures are encountered and in aircraft equipment where flame-inhibiting characteristics provide increased safety. The flame-retardent feature has no detrimental effect upon either the machining properties or electrical values of the laminate.



American Lava Corp.

Fig. 6—Metal-ceramic combinations for hermetic sealing of components. Coefficient of thermal expansion can be matched with that of any metal.

Taylor Fiber Co. also will be among the exhibitors, with laminates in a variety of compositions and shapes—rod, sheet, roll, tubing, and fabricated forms.

TECHNICAL CERAMICS

Development of new ceramic materials not only for refractory but also for seals, filters, and machine elements has proceeded at a rapid pace in recent years, with the result that today some compositions are available that are harder and more wear resistant than many metals and metal carbides. These are fine grain ceramics which can be polished to high smoothness.

Another new and interesting technical ceramic developed by American Lava Corporation has excellent electrical properties and can be safely used at temperatures in the area of 4,000 F. It is finding increasing favor for insulators for cathode heaters in electronic vacuum tubes.

Porosity of parts can be closely controlled. Some have no moisture absorption at all. The dense materials will hold vacuum or pressure. The more porous materials can be used as filters, catalyst carriers, breathers for dust proofed containers.

Another interesting feature is that coefficients of thermal expansion can be controlled and varied over a wide range. Thus, expansion can be matched to that of other materials, as for seals, Fig. 6.

LOW ALLOY PERMANENT MAGNET MATERIALS

One of the fields being focused upon by researchers is that of hard and soft magnetic materials. Object: to find an alloy or series of alloys with properties equal to or approaching those of the Alnico materials, but requiring fewer strategic metals, and thus being less costly to produce.

Just being introduced in this country are the Ferrodure compositions developed by N. V. Philips Gloeilampenfabrieken, Netherlands, and being handled here by Philips Laboratories. Licenses have been taken here also by a number of other companies.

Ferrodure is basically a sintered oxide of iron and barium with a hexagonal crystal structure. Like the ferrites, this material is non-metallic and thus contains no nickel, chromium, cobalt, or other strategic materials; mechanical properties are similar to the ferrites. It is pressed to the desired shape before firing, and can be ground after sintering.

Physical properties of interest are (1) low specific gravity, about 4.5 compared to 7.5 for most magnet steels; (2) high resistance to demagnetization at temperatures up the Curie point 450C; (3) high coercive forces, with the intrinsic value being about 2,900 oersteds; and (4) high specific resistance.

Applications include, among others, TV focusing magnets, dynamos and motors, loudspeakers, and high frequency circuits. In this latter use, magnetic biasing can be applied in coils, pulse transformers, relays and magnetostriction vibrators.

HIGH STRENGTH STEELS

Demands from the military—primarily the Air Force and Navy's Bureau of Aeronautics—have resulted in a start on high strength steel research that is very encouraging but not yet definitive. Of the alloys thus far produced experimentally, some have tensile and compressive strengths exceeding 200,000 psi and researchers are looking forward to a producible composition having an ultimate tensile strength exceeding 250,000 psi.

Table IV—Properties of Unplasticized PVC Plate

Mechanical Properties at 75 F	
Tensile strength, psi	8,500 to 9,000
Compressive strength, psi	11,000 to 12,000
Modulus of elasticity in flexure, psi	480,000 to 540,000
Izod impact strength, notched, ft-lbs/in. (1/8 in. x 1/2 in bar)	0.4 to 0.5
Rockwell hardness, R Scale	117 to 120
Shore hardness, D Scale	85
Thermal Properties	
Heat distortion temperature, C at 66 psi	73–75
Electrical Properties	
Volume resistivity, ohm-cm at 90 C	1.3×10^{16}
Dielectric constant, 1,000 cycles at 23 C	3.25
Loss factor, 1,000 cycles at 23 C	0.072
Dielectric strength, volts/mil (30 mil plaque)	725
Specific gravity	1.40
Flamability	Self extinguishing

There's one major problem: all the alloys investigated so far are extremely brittle. Parts having sharp radii or surface notches not only fail under heavy load, they practically disintegrate. Nevertheless, such steels have been used experimentally for aircraft landing gear structures with good results, and within about two years, should be in use for other structural components on aircraft.

RIGID PVC

Rigid polyvinyl chloride has excellent corrosion resistance and can be machined, drilled, sawed, punched, stamped, embossed, cemented, welded using the hot gas technique and formed under heat and pressure; it has significant potential in the chemical and process industries where a material with such characteristics is especially desirable.

The Firestone Plastics Division of the Firestone Tire and Rubber Company lists two formulations under its Exon tradename. Exon 402 A, Table IV, is designed for unplasticized rigid applications and can, when compounded with efficient stabilizers and lubricants, be processed by standard calendering, laminating, molding, and extrusion techniques into a thermoplastic construction material. Firestone claims it to be inexpensive, easy to process, and available in commercial quantities.

Exon 860 is a rigid thermoplastic resin having good dimensional stability and electrical properties, and high impact strength.

FLUOROCARBONS

Besides exhibiting specialized properties in molded and sheet form, hydrocarbon compounds such as DuPont's Teflon, M. W. Kellogg's Kel-F, Union Carbide and Carbon's Fluorothene, and Firestone's Exon XR-61 show excellent promise for paints, hydraulic fluids, fire extinguisher fluids, rubber compounds, and allied products. With Minnesota Mining's entry into the field, plus unprecedented demand for military and electronic applications, the entire industry has shifted into high gear. Potentialities of these materials have not yet been scratched, however, and concentrated research is expected not only to broaden forms and applications but to ultimately reduce price.

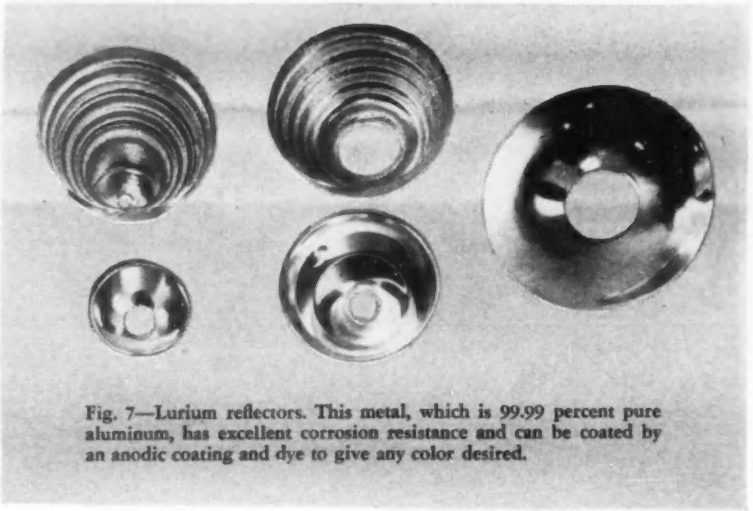


Fig. 7—Lurium reflectors. This metal, which is 99.99 percent pure aluminum, has excellent corrosion resistance and can be coated by an anodic coating and dye to give any color desired.

HIGH PURITY ALUMINUM

Pure metals often exhibit properties entirely unlike metals containing even small amounts of other elements. Such is the case with aluminum.

A series of high purity aluminum metals produced in Germany and being introduced in this country by the Fromson Orban Company under the tradename of Lurium are capable of taking a high polish and will not tarnish or lose luster when submerged in salt water.

Basis of Lurium's unusually high finish is a patented European method of producing aluminum that is 99.99 percent pure, the highest purity ever achieved commercially. Typical applications abroad include ornamental trim for automobiles, stoves, refrigerators, radio and television sets, costume jewelry, lighting fixtures, reflectors and many other uses where light weight and high metal luster are particularly desirable.

Extremely light in weight—one-third the weight of brass or copper—pure aluminum can be alloyed with varying percentages of magnesium for different applications, Table V. It is a work hardening alloy, easy to fabricate and may be anodized and dyed in any color to simulate gold, silver, platinum, copper, brass or any other alloy. Material cost in finished form is said to be less than any of these metals.

Lurium will now be available here in commercial quantities of raw mill forms in all standard shapes, sheet, coils, strips, bars, tubes, wire and extrusions, in soft, half hard, and hard tempers. First shipments arrived from Germany in March. Current deliveries are on a 6-10 weeks basis.

SILICONES

Seldom is a group of engineering materials developed to the commercial stage without losing, somewhere along the way, some of the outstanding properties and characteristics predicted by the developers. Consequently, the applications never quite reach the potential that has been anticipated.

Such has not been the case with silicones. If anything, their forms—rubber, mold lubricants, defoaming agents, protective coatings, insulating varnishes, hydraulic fluids, water repellents, paints, and lubricants—and application have far surpassed anything envisionaged a few years ago.

Using silicone electrical insulating materials, motors have been built that operate in excess of 575 F, a temperature that would cause ordinary insulation to break down in a few hours.

The usefulness of various silicone products as dielectric materials in electric motors for industrial, aircraft and Naval installations has been demonstrated as has their use in transformers for military and industrial uses; in generators and electronic devices including sub-miniature parts and printed circuits, transformers, amplifiers and condensers.

New silicone products are constantly being developed. Some of them now being evaluated promise to be at least as important to design engineers

Table V—Composition and Properties of High Purity Aluminum Alloys

Chemical Composition Limits—Per Cent			Mechanical Properties				
Aluminum	Magnesium	Other	Temper	Tensile Strength, psi	Yield Strength, (0.2%) psi	Elongation, % on 10 dia.	Brinell Hardness
99.99	———	0.01 max.	Soft	6,000– 8,500	2,100– 3,500	40–60	13–18
			Intermediate†	10,000–13,000	4,200–10,000	8–15	18–25
			Hard	15,700–20,000	14,200–18,500	4–8	26–35
*	0.4–0.6	0.02 max.	Soft	10,000–14,200	2,800– 5,800	20–40	22–28
			Intermediate†	15,600–21,400	14,200–20,000	6–15	35–45
			Hard	23,000–27,000	21,300–25,800	2–6	40–50
*	0.8–1.2	0.02 max.	Soft	14,200–18,500	4,200– 7,100	20–35	30–35
			Intermediate†	20,000–24,200	14,200–21,300	8–15	40–50
			Hard	25,700–35,600	23,000–30,000	2–6	50–60
*	1.5–2.5	0.02 max.	Soft	21,400–28,600	7,100–14,200	20–35	40–50
			Intermediate†	30,000–35,500	25,800–32,800	6–15	55–75
			Hard	35,500–50,000	34,000–45,500	2–5	70–80

* Pure aluminum.

† Choice of quarter hard or half hard material.

as the many silicone products now in industry. Among the new products are more textile finishing materials, other water repellent materials for concrete and possible use as soil stabilizers, new and improved electrical insulating materials, and resins for formulating heat stable, weather resistant protective coatings including air drying paints.

LARGE MOLDINGS

In the mushrooming plastic industry, no trend is bigger than the use of large plastic moldings to replace die-castings, and machined metal and wooden assemblies.

To be useful in large moldings, a plastic material must have rapid flow characteristics. To date the most satisfactory materials have been the thermo-setting plastics.

Phenolics, the most commonly used, offer one limitation—color. Practically all phenolic moldings are black, brown, mottled or a shade of red. Although ureas and melamines are unlimited by color (any shade except completely transparent), they too suffer a production restriction. Because these last two plastics require two to three times as much molding pressure as phenolics, the size of parts that can be molded is more closely restricted by present press capacities.

As a result, designers have recently been looking to the styrenes as a possible answer. These have no color limitations, and rapid flow characteristics can be imparted.

At the present stage of development, it appears that styrenes will require additional preheating before they are molded. This to assure rapid flow to all parts of the dies.

ZIRCONIUM

In the same family as titanium and almost twice as heavy as steel, zirconium does not absorb neutrons to any extent. For that reason, atomic energy scientists have used it in structural members of nuclear reactors. They've discovered that this metal possesses unusual strength, corrosion resistance, and high temperature properties on a par with titanium.

Discovery of these unique characteristics has opened wide the potential applications of a formerly useless metal, particularly where high temperature strength is essential, such as in jet engine parts.

Like titanium, the big problem with zirconium is availability. Extracted from sands by a technique similar to the Kroll process, production is measured in pounds rather than tons. In addition, the Atomic Energy Commission, has kept many of its most spectacular properties a military secret to prevent creating a demand and competition for the limited amount of metal available.

Now, with government help, new producers are entering the field. Current suppliers (of which the largest is probably the Westinghouse Electric Corporation) are boosting capacity. The prospects are that within a year there should be sufficient zirconium metal for concentrated research on its properties and fabrication.

Zirconium shares with titanium one other problem, machineability. Reports indicate that it is practically impossible to fabricate by conventional means. As a result, much process research is under way to develop new techniques and machine tools to work zirconium.

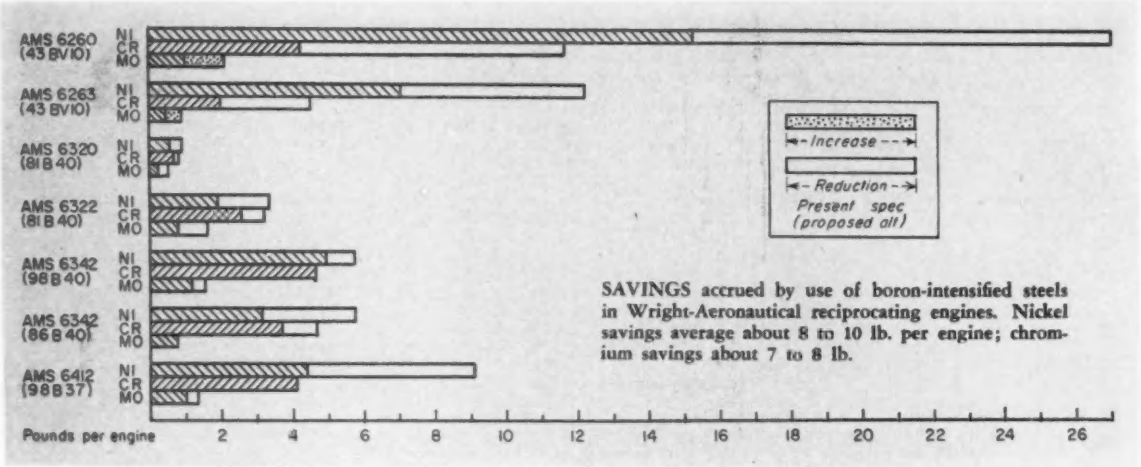
COMPOSITE METALS

Developed to overcome the engineering limitations of single metals, composite metals provide a combination of desirable properties not attainable with a single metal. When properly applied they also increase overall strength, decrease material weight, improve fabricating characteristics, save critical alloying materials, cut costs.

They all consist of two or more single metals inseparably bonded, usually under heat and pressure, to produce a material with each layer of uniform thickness.

Among the composites available commercially today are: aluminum base, iron and steel base, stainless steel clad metals, special spring metals, brazing metal cladding, thermostat metals, rare and precious clad metals.

The possible uses of metal composites seem sure to expand as users become more familiar with their properties and fabricating techniques. Progress is already reported with new combinations for specific functions. Typical of these: molybdenum-clad cupro nickel, calcium-clad nickel, copper-clad magnesium, copper-clad nickel, and nickel-clad copper. From these, it is obvious that effort is being expended to develop suitable substitutes for some of the hardest-to-get materials, and to reduce the weight of those needed.



SAVINGS accrued by use of boron-intensified steels in Wright-Aeronautical reciprocating engines. Nickel savings average about 8 to 10 lb. per engine; chromium savings about 7 to 8 lb.

Protect Yourself Now Against Future Materials Shortages

Fundamental approaches to materials conservation with supplemental information on current government controls. Based in part on a program sponsored by the Eastern Air Procurement District of the Air Force for manufacturing and fabricating companies.

JOHN KELSO
Metallurgical Engineer
Wright Aeronautical Division
Curtiss Wright Corp.

WHILE THE MATERIALS AVAILABILITY outlook is presently more favorable than at any other time in recent years, the still-existent shortages in high-alloy metals indicate that the need for conservation is far from ended. As a matter of fact, if the Paley report and other impartial surveys are any indication, we may never again be able to specify metals without first considering both long and short term availability.

Materials substitution, which is the short term answer, is only one facet of the problem. Effective conservation is a combination of substitution plus

(1) More exacting design;

(2) An analysis of existing production techniques with respect to possible changes; and

(3) Comprehensive testing to insure that the product will meet service requirements, but not so greatly surpass them as to be uneconomical.

Although these points would seem to be obvious, they are consistently disregarded by many designers, partly through carelessness, partly because of lack of time and—sometimes—partly because of high priorities.

Exacting Design

The need for more exactness in engineering design cannot be overemphasized. "Over-design", often viewed as a precautionary factor, but frequently fostered by access to high priority ratings and the seemingly limitless resources of the purchasing department, has contributed to the unnecessary utilization of high-alloy materials. Quite often it is necessary to design for maximum service life in applications where price is no deterrent and where product failure would be extremely serious. This is true in the aircraft engine industry, for example, where the direct aim is to lengthen the periods before major overhaul. Reciprocating engines have an average life, between overhauls, of 1,600-1,700 hrs, or when translated by average speeds, more than a half-million service miles. And certain parts have considerably longer life. However, unlike aircraft engines, most products are designed for a specific service life, and the use of highly alloyed metals to extend the life of one part beyond that of the assembly as a whole is usually unwarranted.

However, a factor contributing to specification of critical metals is designing for the most severe service conditions. While this approach may be justified, peak conditions frequently can be minimized. Even in aircraft engine production the severity of operating conditions can be decreased by improvements in design.

The small turbine wheel hub of the Wright 3,500 hp turbo-compound engine demonstrates this. The original designs specified Inconel "X", a nickel base alloy bearing approximately 15 percent chromium, 2.5 percent titanium, and 1 percent columbium. Alterations to this design resulted in more efficient cooling accompanied by a decrease in operating temperature to a point where a 1.25 Cr-0.25 V heat-resistant material is possible. Since the hub forging, three to an engine, weighs about fourteen pounds, the alloy saving is considerable.

Also, presently under experimental evaluation is the production of an exhaust duct from ceramic coated low carbon steel instead of stainless steel. Here again the problem was to lower the operating temperatures to the point where the low carbon steel base would stand up.

In aircraft, a major doctrine of the designer is—keep it as light as possible. He can practice his biggest economy in the saving of weight, a byproduct of which is materials conservation. A high alloy metal, with little excess to be removed after forging, results in a high-strength high-quality connecting rod, for example, if close control is maintained during fabrication and heat-treatment to prevent decarburization and the formation of surface defects that cause stress concentrations and ultimate failure in fatigue. This approach plus more exacting design in the shape of generous fillets and radii is necessary in aircraft engine manufacture.

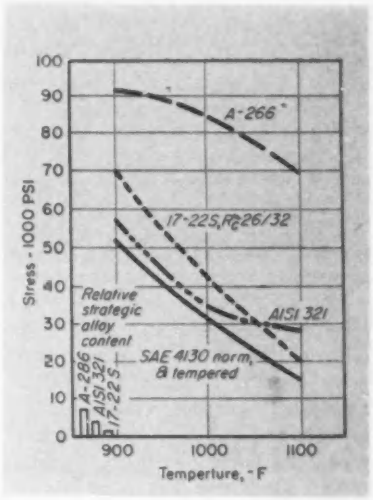
In other industries, a greater allowance for machining—or the specification of an excess of stock if no machining is to be performed—often results in the use of material with a lower alloy content. Weight is higher, some surface imperfections may be present, but with a "beefed-up" cross section, performance is satisfactory.

Comprehensive Testing

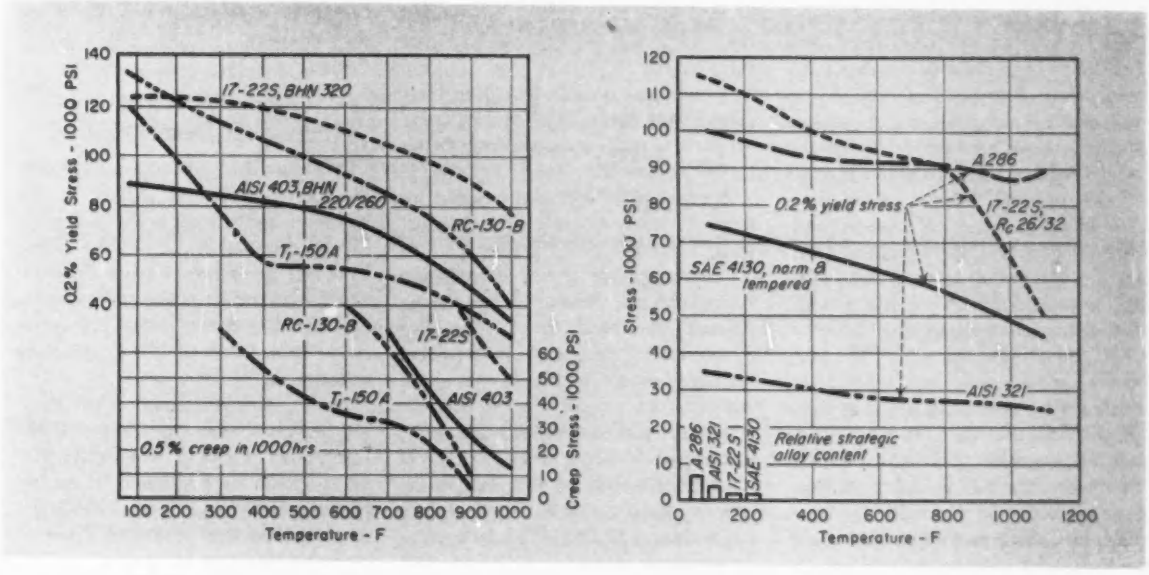
Narrowing the safety factor, a result of decreasing weight, is another means of conserving materials. In aircraft engine production, the safety factor may be on the order of 1.2-1.5/1 against a factor of safety in other industrial designs of from 3 to 4/1, but these lower values have been checked by thorough analysis and test.

In most industries, establishment of safety factors based on guesswork and "experience" no longer occurs, but only in a few is exacting calculation practiced, supplemented by exhaustive stress analysis of components and life testing of finished products. Perhaps the automotive manufacturers with their cost approach to design, are the best example of an industry that has established definite performance requirements and designs to meet them—but no more. How many miles in low gear before failure? Any automotive designer can tell you. How many stress reversals on a drive shaft before breakage? They can tell you. Cost and performance are balanced, and materials requirements are kept to a minimum in terms of both amount and alloy content.

And, of course, continuous product testing provides the key to changes, whether in materials or design. In aircraft engine production, the parts that go to make up various models are under constant surveillance with re-



1,000 hr rupture stresses vs. temperature in combustion chambers sheet materials.



Comparison of 0.2 percent yield stress vs. temperature in compressor blade materials.

Comparison of 0.2 percent yield stress vs. temperature in combustion chamber sheet materials.

Alloy Distribution in Turbo-Jet Engine by Components, Percent

Component	NI	CR	W	CB	CO
1. Compressor Rotor	2.5	6.9			
2. Compressor Stator	2.9	14.3			
3. Center Main Brg. Support	13.5	1.0			
4. Burner Plate Assy	8.1	2.9			
5. Combustion Chamber	10.5	24.0	16.0		
6. Turbine Rotor	17.0	6.8			
7. Turbine Stator	34.8	21.9	38.0		
8. Main Bearings			24.0		
9. Exhaust Cone	7.7	16.2	22.0		
10. Miscellaneous	3.0	6.0		100.0 (WELD ROD)	

spect to "downgrading" their alloy content. On the test stand where every attempt is made to simulate anticipated operating conditions, an experimental engine often parallels a production engine. If the experimental engine passes the test satisfactorily, materials and designs used in it are incorporated into production models. Component testing is a continuous operation.

Production Analysis

An analysis of existing production techniques can realize profitable materials utilization. Weight studies have indicated that utilization percentages of high alloys vary from one form to the other. In certain turbo-jet designs large amounts of materials in the stainless (both hardenable and austenitic) and heat-resistant groups appear in a variety of forms such as: sheet, tubing, forgings, casting, bar, and wire.

An original turbo-jet design specified that certain flanged rings at the middle and rear of the engine be made from heavy pot-type centrifugal castings of a high chromium-nickel-tungsten alloy. The castings required radiographic examinations to insure quality, and machining operations, which cut the casting to only a fraction of its original weight, were time-consuming and costly. Re-design specified a ring with greatly reduced cross-section fabricated from a mill-rolled and butt-welded bar of a less strategic chromium-nickel analysis.

In the production of a "Y" duct, welded steel tubing was used previously and a manufacturing change employing sheet steel not only saved critical materials but also production time. The tubing had to be bent, cut, fixtured, and welded. The sheet steel was stamped so that half shells were formed, and seam welding was used to complete the duct.

The analysis of forgings vs stampings, castings vs forgings, extrusions vs machined sections, and of other methods of forming and assembly is often neglected after designs have been finalized.

Continuing attention to methods will pay off in less scrap and better utilization of materials.

Materials Substitution and Downgrading

This approach has and is still receiving the attention not only of industry but of the military organizations and other government bureaus. (See *Product Engineering*, October, 1950). Several comments still are in order.

Plating and coating techniques are worthy of consideration in materials economy. A successful application in aircraft engines concerns the finishing of aluminum piston ring "belts" by the electroless nickel plating process. The tail cone at the rear of a turbo-jet engine reveals another economical sheet metal story. Subject to thermal stresses and fatigue loads, the assembly has been fabricated from stainless type AISI 310. Use of an alternate ceramic coated carbon steel is contemplated—a combination imparting greater heat conductivity, and damping properties with accompanying better fatigue resistance.

For low alloy steels, the boron intensified steels in both through-hardening and carburizing grades seem to be the acceptable choice in reducing alloy content. *Product Engineering* Annual Handbook for 1953). For downgrading programs, boron steel has been endorsed by the government agencies. In aircraft engine use, articulating rods, compressor rotor disks, and accessory drives seem to be good substitute possibilities. In a compressor rotor shroud, 81B40 can replace AMS 6412 (SAE 4337); in a compressor rotor disk, 98B40 can replace AMS 6342 (SAE 9840); in turbine and compressor rotor shafts, 98B37 or 98B40 can replace AMS 6412 (SAE 4337).

In a direct effort to conserve columbium, in a columbium bearing 18 chromium—8 nickel stainless steel, the titanium stabilized grade AISI321 was substituted. A still further change to AISI304 with controlled carbon composition (0.06 max.) has been specified. By keeping the carbon content at this figure, brazed assemblies do not exhibit harmful carbide precipitation.

Over the stainless grade type AISI-403 now in use for compressor blading where the trend is toward higher compression ratios and, therefore, higher operating temperatures, two materials appear to have the necessary qualifications.

One of the better grades of titanium alloy exhibits satisfactory yield and creep stress up to operating temperatures of 700-800 F. In the 800-1,000 F range, low alloy 17-22S shows good yield and creep stress properties but requires the incorporation of a suitable coating to provide the necessary protection against corrosion.

Committee Action or Individual Responsibility?

Whether the responsibility for conservation should rest solely in the hands of individuals or be delegated to a committee is beside the point. The fact is, however, that "preventive" conservation is the best program for effective results, and preventive conservation starts in the engineering department.

Placing the emphasis on the engineering phase does not mean that the many other phases of an effective program should be neglected. It merely provokes the thought that if a material or component can be designed out of a product, it never reaches the production floor to impose further burdens on those who must handle and dispose

How The New Defense Materials System Will Operate

When the Defense Production Act expires July 1 and the 2-year old Controlled Materials Plan ends, a new priorities and allocation scheme, the Defense Materials System, will go into effect, calling primarily for:

(1) Quarterly allotments of steel, copper, and aluminum by Defense Department and Atomic Energy Commission to their prime contractors, and

(2) Direction by the National Production Authority to steel, copper, and aluminum producers to set aside specific tonnages for defense-rated business. Probable for third quarter: steel, 15 percent of total production; copper, 25 percent; aluminum, 30 percent.

Under this new system, contractors will also receive preference ratings to buy necessary equipment, and their priorities can be passed on to sub-contractors and suppliers, who in turn will have priority on materials. Priorities will also be issued to selected defense-supporting projects, but manufacturers or construction contractors receiving this type of rating will have to be certified specifically by AEC or the Pentagon. Examples: An electric utility plant to power an atomic energy project, a machine tool builder supplying an automotive equipment maker who has a military contract.

No other controls or priorities are involved with DMS, since officials at the Office of Defense Mobilization—which will continue to be the top Civilian Defense agency—want to keep the system as simple as possible. But this decision to limit priorities has brought objections from industries like petroleum, electric utilities, and farm machinery who want treatment on a par with military and atomic energy contractors. Because there are no controls or priorities on steel, copper, and aluminum for non-defense consumers, it will be on a "first come, first served" basis, unlike under CMP when quarterly metal allotments were issued to all consumers.

Presently there's no legislative authority for DMS, although it is assumed that Congress will extend the Priorities and Allocations Provisions of the Defense Production Act. The Capehart Mobilization Bill contains such provisions.

One significant type of metals control will continue after June 30: Complete allocations on such scarce alloys as nickel, cobalt, tantalum, columbium, molybdenum, titanium, and diamond bort. To all intents and purposes, controls on steel, copper, and aluminum no longer exist. Consumers finding mills to supply them can buy in excess of their April-June allotments. Conversely, as soon as CMP orders on their books are filled, mills can sell to any customer. This differs from the previous law in that, as additional mill space developed, producers were unable to sell unless customers were issued supplemental allotments by NPA.

But Washington officials are not sure the CMP modifications have made too much extra metal available. In general, the big steel mills have been booked through the second quarter. Aluminum order backlogs have been tied up similarly. The copper situation does not permit any accurate forecasting: Before price controls were dropped, monthly allocations of refined copper to brass mills, wire mills, and foundries were running about 10,000 tons shy of requirements. Price decontrol is expected to boost supply by at least 5,000 tons a month.

Additional steel may be on the market soon. United States ingot capacity is expected to increase 7 million tons by the year's end, some of which should be coming in during the current quarter. Aluminum would be abundant already if it were not for a recent drop in production, resulting from drought-induced Pacific northwest power shortages. Part of the losses will be regained by special shipments of Canadian aluminum pig to U. S. primary products. Arranged by ODM, Canadian aluminum originally intended for purchase by Great Britain was diverted to this country. Later the aluminum will be resold by United States primary producers if the British government wants repayment.

The U. S. government, incidentally, stepped out of the aluminum expansion picture in February when the Wheland Company, Chattanooga, Tennessee, entered the business to become the fourth new post-Korea primary producer. The others are Anaconda Copper, Olin Industries, and Harvey Machine Company. The expansion program will hike domestic capacity from 719,000 tons annually in 1950 to at least 1,746,000 tons in 1955. Aluminum consumers are beginning to get their first big dividends. Second-quarter 1953 domestic output will probably hit 310,600 tons—the highest in history—and by the end of the year, production will be running at about 345,000 tons quarterly.

As things stand now, here's how the government rates supplies on specific metals:

In "Fair to Good Supply"—lead, zinc; in "Approximate Balance"—aluminum copper, tin, tungsten; in "Short Supply"—beryllium, selenium, platinum, cold drawn and hot-rolled alloy steel bars, heat-resistant alloy steel castings, steel plates and structural shapes; Still "Most Critical"—nickel, cobalt, molybdenum, columbium, tantalum, titanium, gray-iron and carbon steel heavy castings (over 3,000 lbs.), nickel-bearing stainless steel, and diamond bort. Last year at this time, 14 other materials were also classed as "Most Critical". Now these are off the danger list.

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of it. Even small unit usage figures, when they are scaled to high production, have a way of transposing themselves into some very large numbers.

In short, the conditions surrounding changes in design fall into three general categories:

1. The original design and its accompanying materials which have been based largely on what the designer felt was necessary.

2. The altered design along with certain materials which now are selected based on what the product requires in view of the results of experimental test.

3. The so-called "finished" or production design where, for the most part, the design and type or class of material have been standardized.

The logical conclusion to draw from the above is that as a product proceeds through these stages, it becomes progressively more difficult to apply alternate materials which are attractive because of their alloy savings. Subsequent changes are made on a purely metallurgical basis or for reasons advanced by the production engineer and/or the quality control engineer and are aimed at such things as better manufacturing techniques, standardization, increased process control, and ease of procurement.

As mentioned previously, such changes may provide a short term answer to conservation, but the long term problem can be solved only by the designer.

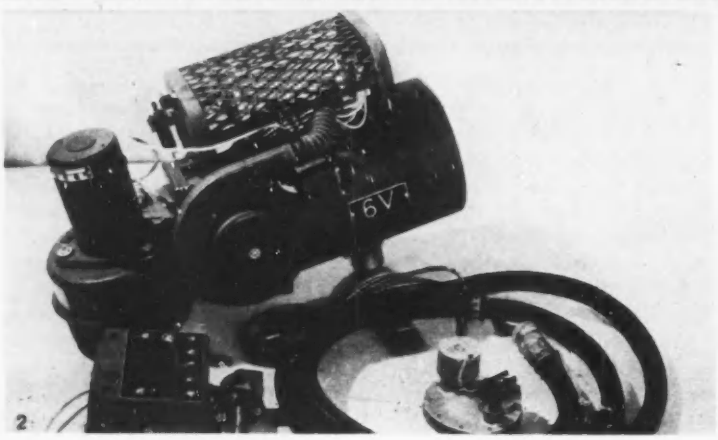
For evaluation purposes, the equipment was used to construct an all-weather landing strip, for which approximately 175,000 cu. yds of fill were required. Temperatures ranged from 0 to —25 F and below. None of the equipment, including trucks, cranes, scrapers, and loaders, was designed for Arctic operation.

Winterization

In an effort to evaluate existing commercial construction equipment for arctic operation, and to obtain data for redesign and modification, the Army Engineer Research and Development Laboratories at Ft. Belvoir, Va. has completed a series of tests on machines and devices ranging from air compressors, generators, and welders to cargo carriers (weasel), cranes, lubricators, shovels, tractors, and dump trucks.[1] Special effort was devoted to component and battery evaluation, and to performance characteristics of oils and greases.

Devices and techniques were worked out to satisfy the following basic requirements:

1. Prevent weather, particularly blowing snow, from affecting the operation of critical components



2

3

IN NEW PRODUCTS

of Construction Equipment

or contributing to their deterioration while idle or in storage. This deals with enclosures and packaging.

2. Assure adequate flow of clean fuel and coolant, and effective lubrication, i.e., high-class servicing, and utilization of products to suit the extreme temperature-duty range involved.

3. Supply and maintain adequate cranking power. Storage batteries and their attendant accessories were the subject of development.

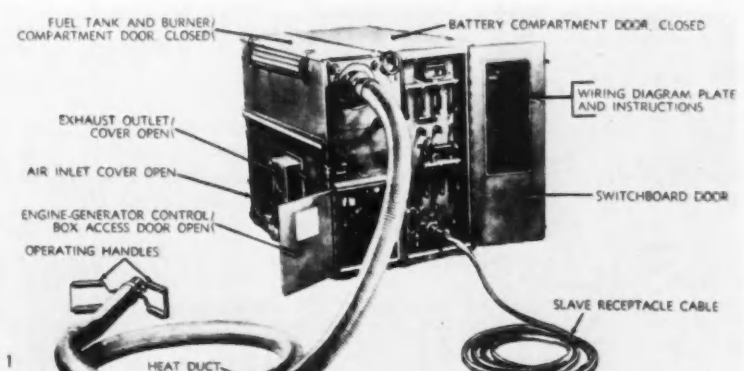
4. Establish and maintain suitable conditions for combustion. Positive fuel distribution, priming, and operational techniques were involved, along with the varying phenomena of carburetion and injection under a wide range of ambient temperatures not usually encountered.

5. Provide and control suitable operating temperatures within the engine and its vital auxiliary equipment, particularly storage batteries, oil pumps, and fuel systems. This factor brings in the winterization heating systems as the nearest approach in one package reasonably proved in practice and available (cluttered though it is in most cases), and an "aspirin" for the several headaches indicated above, for operations below —25 Fahrenheit.

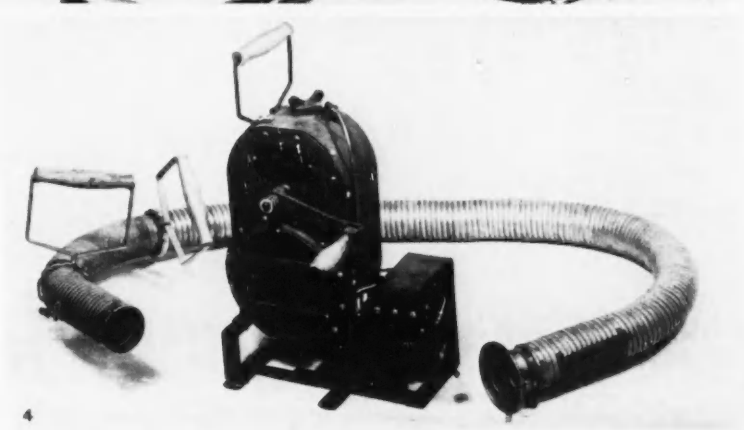
6. Crew comfort and defrosting.

Data in these and following pages were supplied by P. W. Espenschade and Mr. Sorensen of ERDL. More information will be presented in a subsequent issue of Product Engineering.

[1]*See also SAE Quarterly Transactions, Vol. 6, No. 4, Oct. 1952, p. 689/709; "Subzero Winterization of Diesel-Engine Power Equipment" based on Paper No. 681, presented at SAE National Diesel-Engine Meeting, Chicago, Ill., Oct. 30, 1951, by Messrs. P. W. Espenschade, R. C. Navarin, and W. W. Van Ness, ERDL, Ft. Belvoir, Va.*



1. Slave kit used for starting internal combustion engines at temperatures down to —35F consists of four 4H, 6V, lead acid storage batteries; a single cylinder gasoline-engine driven 1,500 w, 30v d-c generator; controls and regulator; switchboard for selection of 6, 12, or 24v circuits; an electric motor driven gasoline burning heater, of 100,000 BTU capacity; and associated electrical connectors.



2. Another type of heater was installed inside enclosures such as vehicle cabs. Termed a fresh air personnel heater for crew comfort and defrosting, it is a forced draft, gasoline burning, electrically operated type.

3. Novel type of fuel dispenser developed for emergency use is applied like an aerosol bomb into the engine air induction system.

4. Small hand-operated slave kit for heating small machanisms and equipment. Capable of 40,000 BTU output with contaminated air, the unit has a fuel tank, filter bowl, float bowl jet assembly, combustion chamber with open flame burner, and a hand-operated blower.

Low-Temperature Storage Batteries

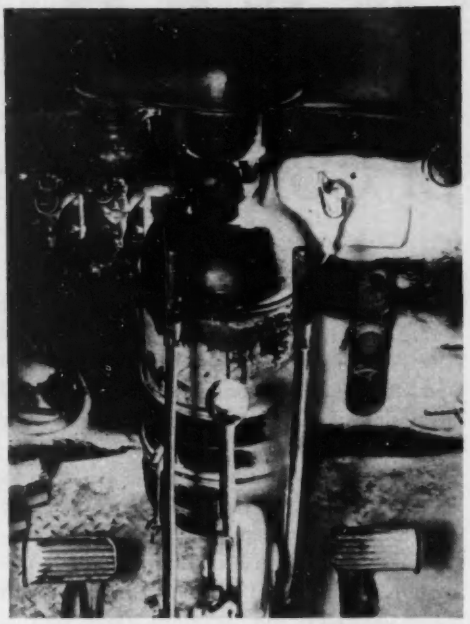
Type	Min. No. Plates	Amp. Rate/ Time, min. At Minus 40 F	General Characteristics	
			Dimensions, in.	Dry Weight, lb
2H (6-Volt).....	17	300/2.25	10¾ x 7⅛ x 9¾	36
4H (6-Volt).....	23	300/3	13 1/16 x 7⅛ x 9¾	47
8T (12-Volt).....	39	300/4	21⅛ x 11 x 10 1/16	124
9T (6-Volt).....	41	300/7	25⅛ x 7⅛ x 11 1/16	126

Note: Above ratings are based on high amperage discharge cold to furnish peak cranking requirements. Control current at low amperage rates cold can be furnished down to minus 65F to activate heaters.

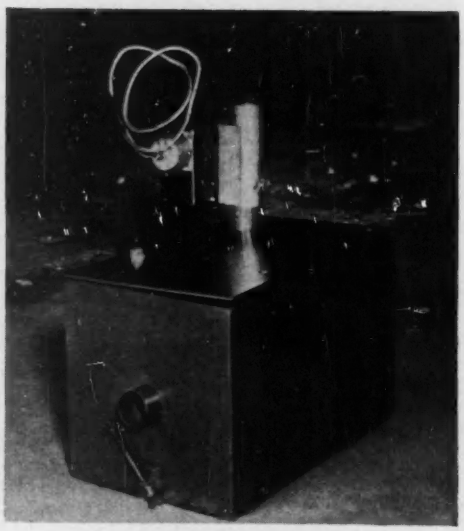
U. S. Army Military Anti Freeze, Fuels, Greases and Oils Utilized in Tests

Ref.	Lubrication Chart Symbol	Product Designation	Specification	Temperature Range, F
1	——	Alcohol, Ethyl	O-A-396	——
2	——	Compound, Anti Freeze, Arctic Winter Type	MIL-C-11755 (Amend. #1)	To −70 F
3	HBA	Fluid, Hydraulic Brake (Arctic)	USA 2-138	To −65 F
4	D35	Fuel Oil, Diesel	MIL-F-896, Class 3 or Class 3 Special (Specify cloud and pour below −40 F)	To −40 F
5	86C	Gasoline, Automotive (Combat)	MIL-G-3056, Type C	——
6	GAA	Grease, Automotive and Artillery	MIL-G-10924	To −65 F
7	WP	Grease, Lubricating, Automotive and Industrial (Water Pumo), Type A, Grade 4	VV-G-632	——
8	GOS	Lubricant, Gear, Universal Sub-Zero	MIL-L-10324 (Amend. #2)	To −65 F
9	——	Lubricating-Oil, Preservative Special	MIL-L-644A	To −70 F
10	OES	Oil, Engine, Sub-Zero	MIL-O-10295 (Amend. #1)	To −40 F or Below
11	OHA	Oil, Hydraulic, Aircraft (Petroleum Base)	MIL-)-5606 (Amend. #2)	To −65 F

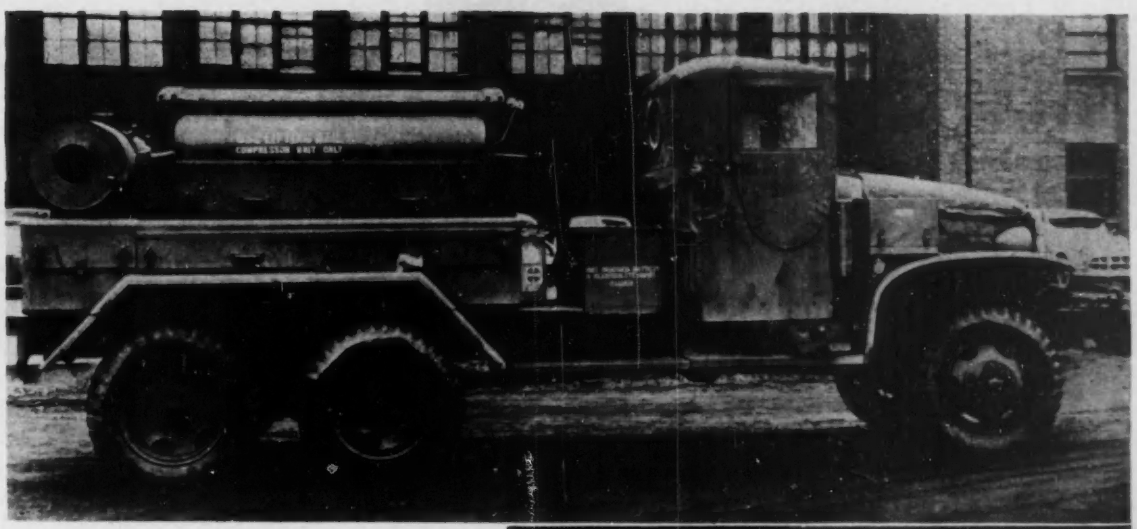
Specifications do not necessarily include all of types, classes, grades, sizes, etc., of the commodities indicated by the titles of the specification, or which are commercially available, but are intended to cover the types, etc., which are suitable or stocked for Government requirements.



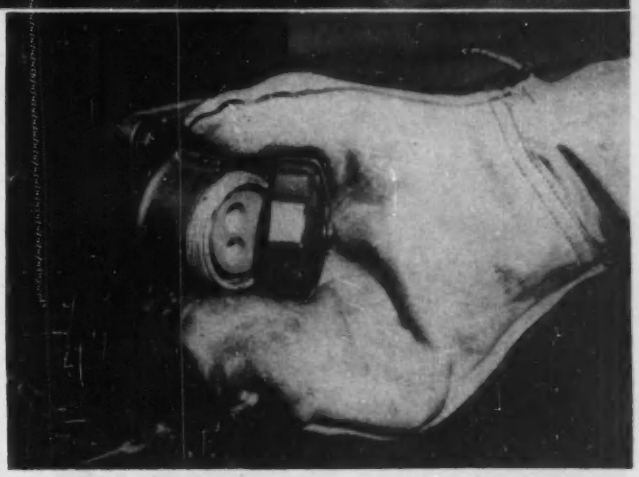
FLUID USED to start engines was packaged in a 10 ml steel bulb and pressurized. When installed, discharger pierces the sealing cap and directs fluid into the intake manifold.



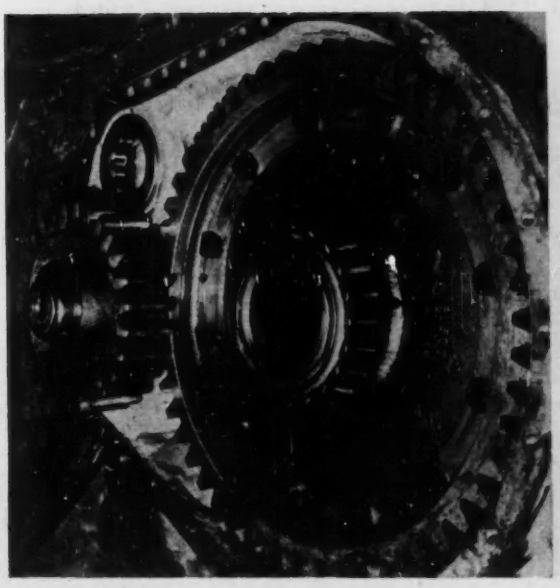
INSULATED BATTERY BOX (upside down) with hot air intake line and control valve. Warm air used to heat the engine block is also circulated through the battery box to maintain a high current output for cranking.

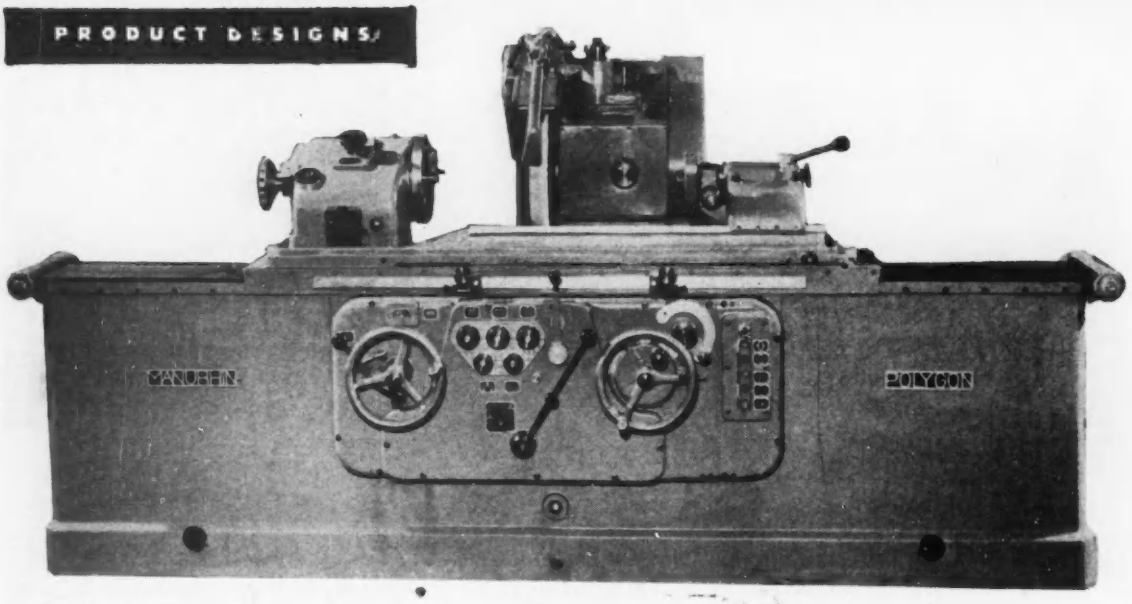


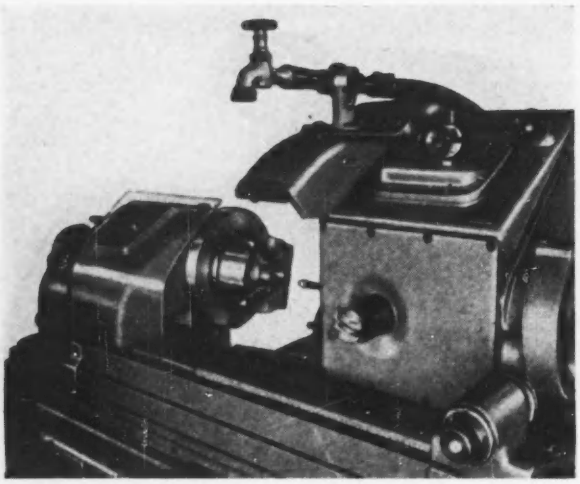
WINTERIZED TRUCK mounted air compressor having a hard top cab, an insulated jacket for the engine hood, an insulated battery box (with the heater on the opposite side) and a battery charging receptacle (right) immediately below battery box.



DISMANTLED EQUIPMENT GEARS and roller bearings from tractor drive (left) and roller bearing assembly from road grader (right) illustrate excellent results obtained with GOS oil and GAA grease respectively. Engine lubrication was equally satisfactory—so much so that no major changes are planned in either oil or grease specifications.



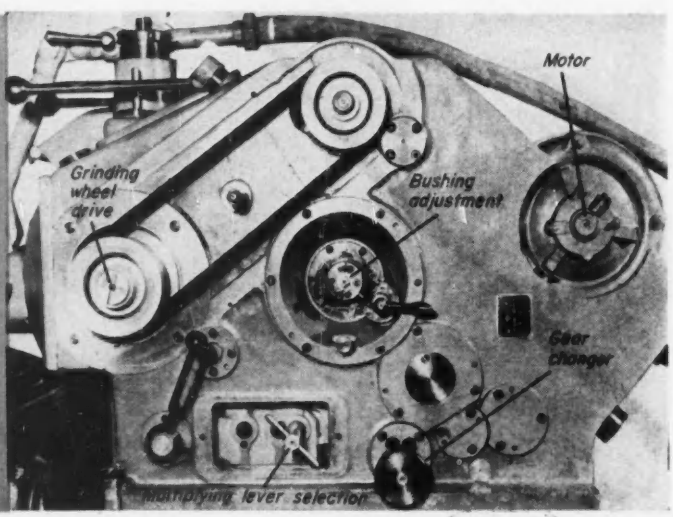




POLYGON GRINDER SETUP for external grinding of polygonal shapes for which work is mounted between centers and driven by the head plate. All shapes may be ground, externally, without moving the work from its original set-up. When eccentric mechanism is disengaged, machine is free to operate as an ordinary circular grinder, turning out round profiles.

WHEN SETUP FOR INTERNAL GRINDING (left), work is chucked in driving head. Dial indicators, inserted into built-in plugs, measure the vertical and horizontal thrust of the grinding wheel as initiated by the eccentric mechanism. In this way setup can be checked for dimensional accuracy before grinding operation is started.

ECCENTRIC MECHANISM that develops gyratory motion of the grinding wheel axis as seen from the exterior, in cross-section, and schematically. Key to the operation is the synchronization of the oscillating motion with the uniform rotation of the work. This is accomplished through the four speed gear box so that by a simple change of a wheel, the grinding wheel performs two rotations while the work performs one (for an ellipse), three while work turns one (for triangle), and four while work turns one (for square). Conjugate bushings are mounted on a cone so they can be moved to vary the throw a minor amount.



Gyratory Motion Grinds Polygons

Imparted to the wheel axis by a driving eccentric, gyratory motion of the grinding wheel enables the Polygon Universal Grinding Machine built by Manurhin, Manufacture de Machines du Haut-Rhin, Paris, France, to form precision internal and external eccentric, elliptical, triangular or square profiles.

The all-important mechanism consists of two conjugate bushings acting on two sliding members that impart horizontal and vertical movement to the grinding wheel. As the bushings rotate, the sliding members follow sinusoidal motions perpendicular to each other. Horizontal movement is transmitted directly through the sliding member, the vertical through a multiplying lever with four different ratios: 1:1 for eccentric, 1:2 for ellipsoid, 1:3 for triangular, and 1:4 for square profiles.

Rotation of the bushings and work are synchronized, so that the latter rotates at one speed for eccentric, twice as fast for ellipsoid, three times as fast for triangular, and four times as fast for square profiles.

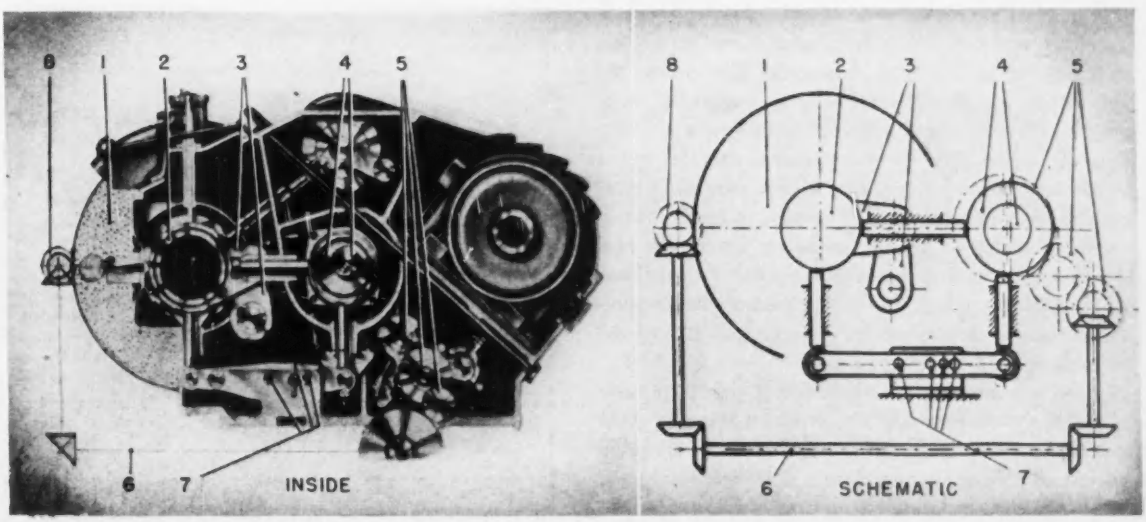
Internal grinding devices are mounted on the same axis as the grinding wheel so the machine can duplicate on the interior the same shape it generates on an exterior surface (with the exception of square internal profiles which cannot be ground internally because of tool clearances in the corners of the shape).

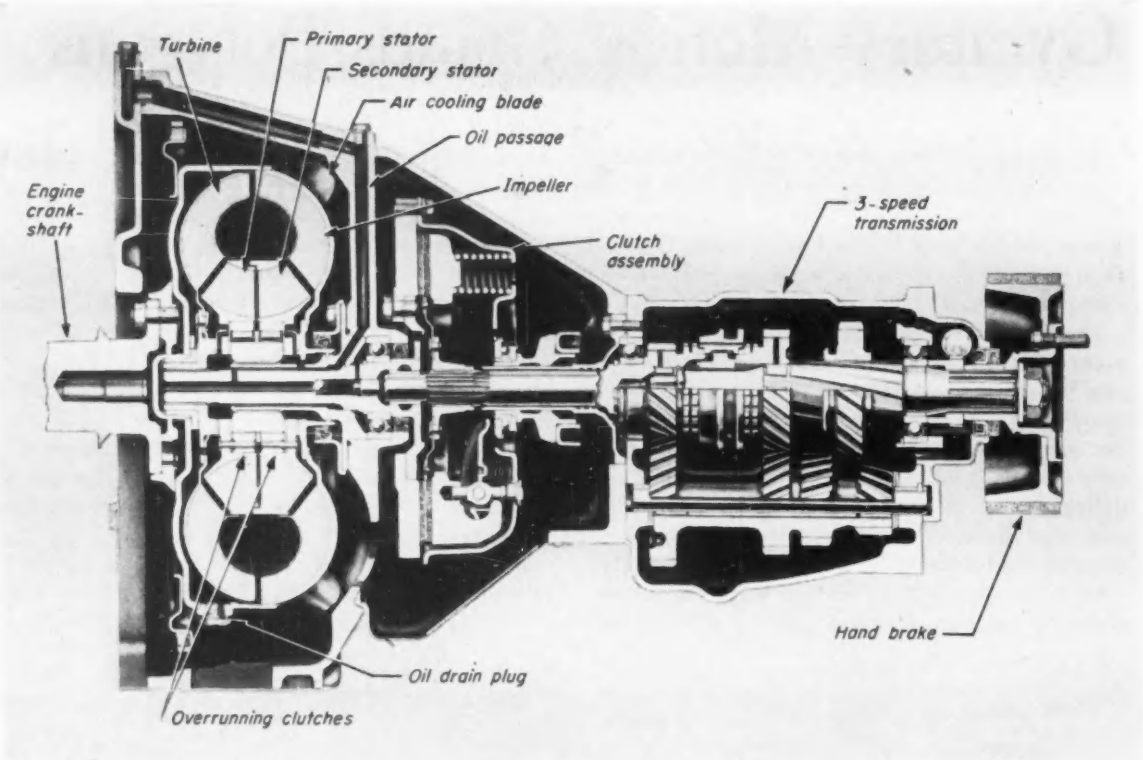
Main objective of the machine is to grind triangular shafts that (1) replace splined shafts for driving purposes or (2) eliminate the need for keyed shafts. All shafts in the Polygon itself are triangular. Instead of being keyed, these shafts are held in place by metallic retaining rings.

All controls are hydraulic and can be set for automatic or manual operation. U. S. Distributor is the S. & S. Machinery Company, Brooklyn, N. Y.

Variety of Shapes That Can Be Generated by the Polygon Grinder

LEGEND: 1. Grinding wheel.
2. Wheel spindle holder.
3. Articulated lines carrying the spindle holder.
4. Driving eccentric bushings.
5. Driving eccentric change gear box.
6. Connection between eccentric and work driving gears.
7. Positions for lever multiplication of vertical motion.
8. Work piece.





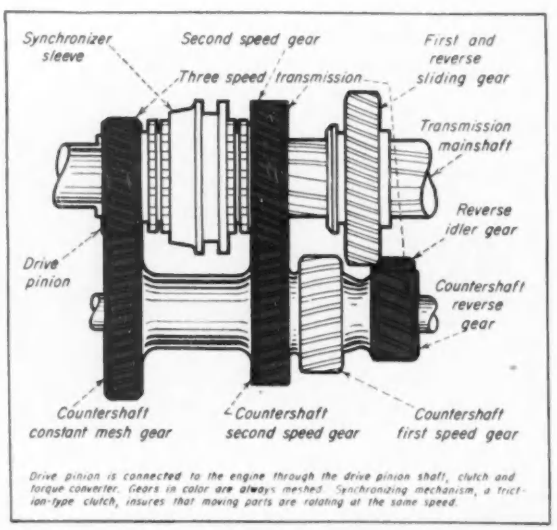
PLYMOUTH's new Hy-drive transmission looks similar to torque converter units with manual clutches already available on other Chrysler Corporation cars. Impeller and turbine are hydrogen brazed assemblies of stamped steel parts. Stators are precision aluminum castings. Converter and clutch housing are die cast from aluminum or magnesium alloys. Cooling blades spotwelded on the outside of the converter sheet eliminate need for separate oil cooler. These blades are spaced around the housing to keep noise levels at a minimum.

Torque Converter Transmission

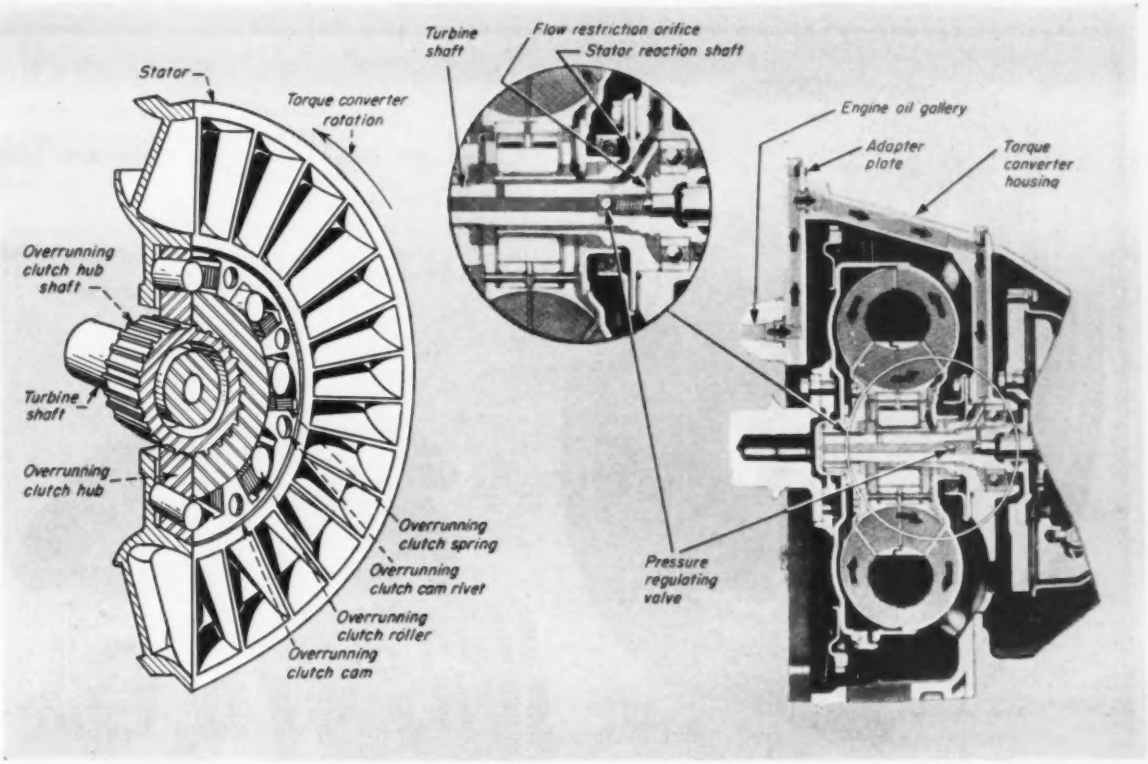
A new torque converter in combination with a manual clutch and three speed transmission will supply no-shift driving in late 1953 Plymouths. Up to now the only major car producer without an automatic transmission, Plymouth has beefed up the basic design available on other Chrysler Corporation cars to get a torque multiplication of 2.6:1, higher than the 2.57:1 starting ratio in a standard Plymouth transmission.

Like other 1953 Chrysler torque converters, the new Hy-drive transmission shares oil supply with the engine, using crankcase oil as the fluid medium. Blades spotwelded on the outside of the converter sheet cool the oil so there is no separate oil cooler.

In the new three speed transmission, first gear ratio is 2.37:1, second gear 1.68:1. Normal driving in third gear does not require use of the clutch after the engine has started. For driving conditions that need extra pull, the driver shift-manually to one of the lower gears.



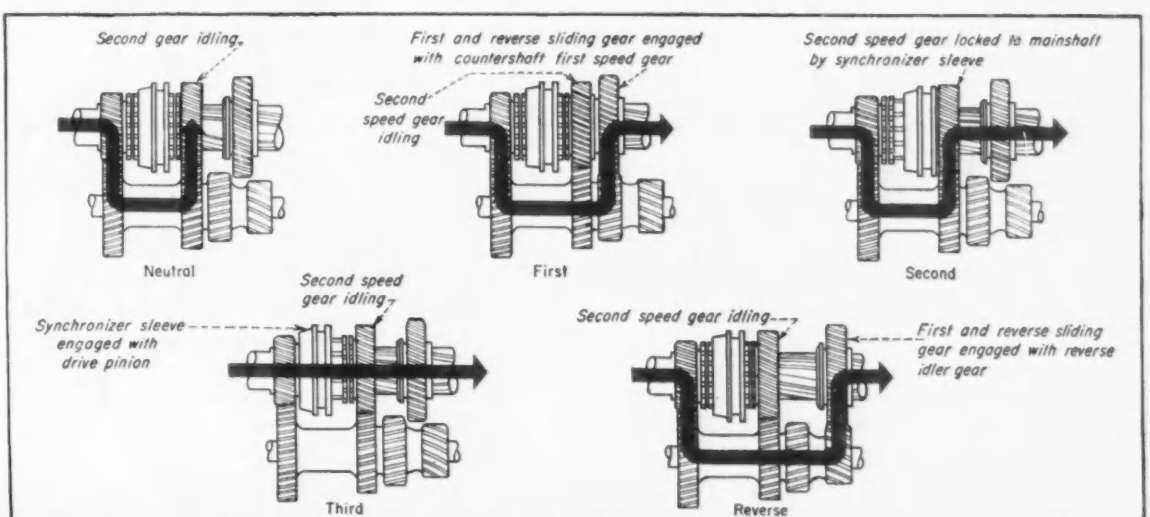
Drive pinion is connected to the engine through the drive pinion shaft, clutch and torque converter. Gears in color are always meshed. Synchronizing mechanism, a friction-type clutch, insures that moving parts are rotating at the same speed.

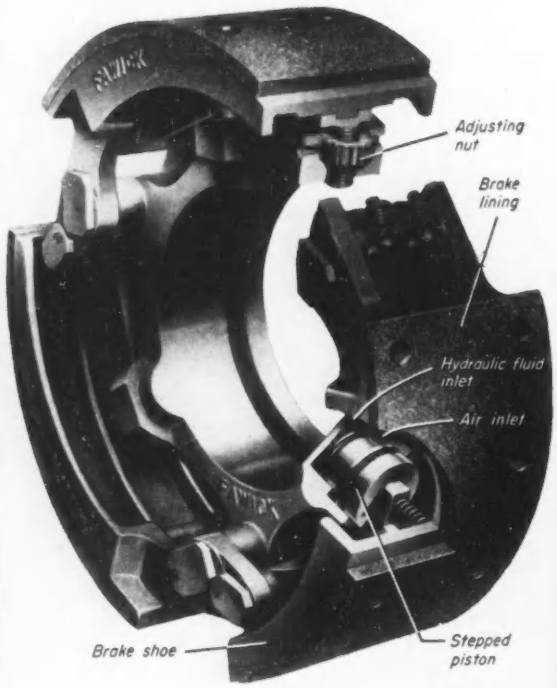


OVER RUNNING CLUTCH, on which each stator is mounted, consists of eight spring-loaded rollers mounted within an internal cam and around the hub periphery. Stator reaction shaft, bolted to the converter housing, holds the hub stationary. Therefore each clutch keeps its stator from rotating opposite to turbine rotation.

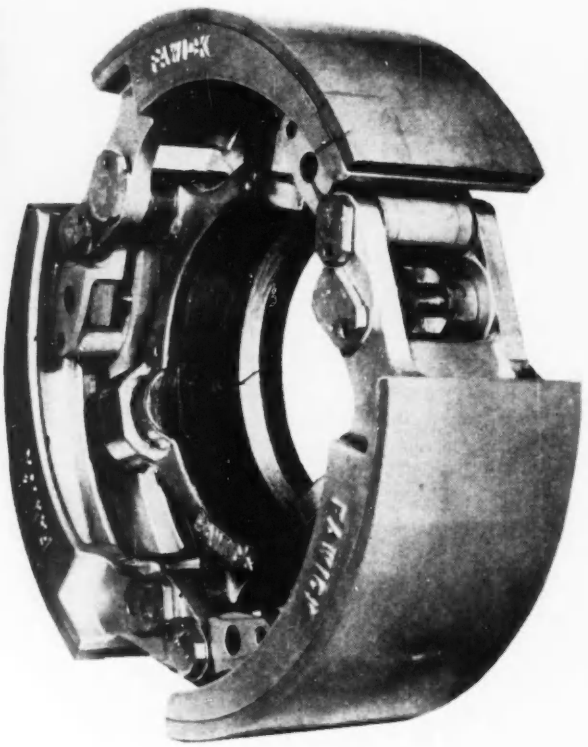
FLOW OF OIL through torque converter. Inset shows regulating valve through which oil returns to engine. It maintains proper oil presure in the engine and prevents oil draining from the converter assembly when the engine stops.

for Late Plymouth Models


Second gear idling
Neutral
First and reverse sliding gear engaged with countershaft first speed gear
Second speed gear idling
First
Second speed gear locked to mainshaft by synchronizer sleeve
Second
Second speed gear idling
Synchronizer sleeve engaged with drive pinion
Third
Second speed gear idling
First and reverse sliding gear engaged with reverse idler gear
Reverse



OPERATING MECHANISM (left) is completely contained in the drum, permitting clean and unfettered axle design—no roto chambers, push rods, camshafts, etc. Partial cutaway shows both operating areas of the piston. Hydraulic fluid acts on the inner, air on the outer. O-ring seals maintain separation of fluid. Adjusting nut permits proper regulation of brake shoe with respect to lining.

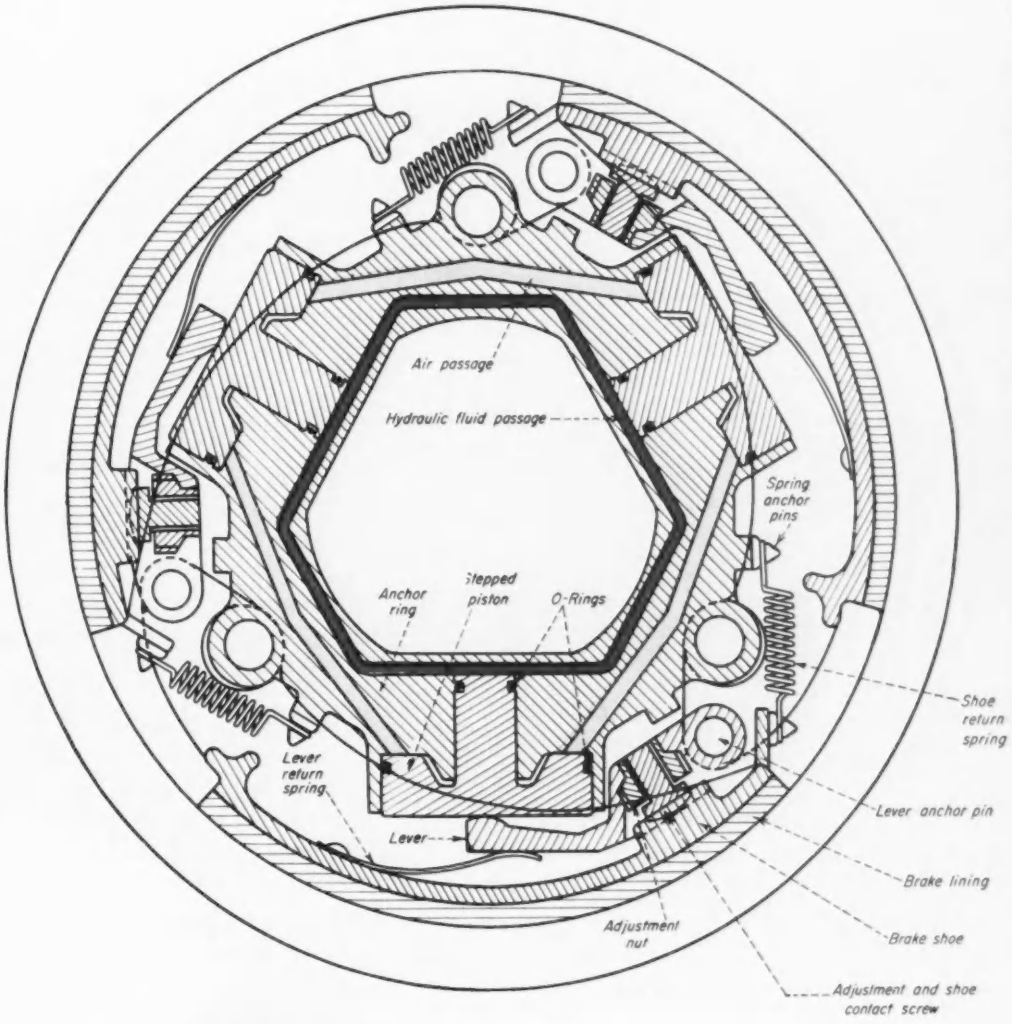


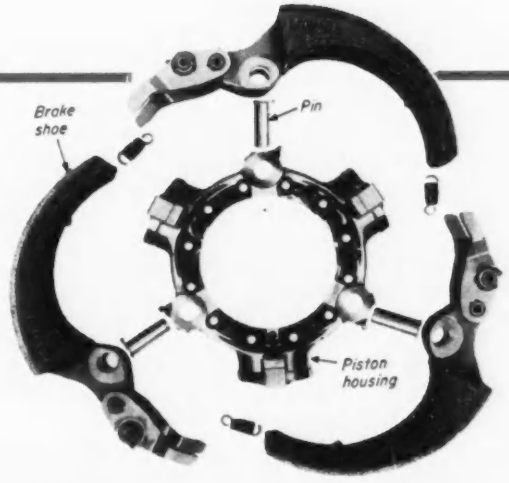
ALL-FLUID BRAKE (right) is operated by two separate independent systems, one for normal service and the other for emergency. In this unit the service system is pneumatic, while the emergency system is hydraulic. Brake is also available, in smaller sizes, with two hydraulic systems. Sizes of Hydro-Air brakes range from a three shoe brake with nine in. dia. drum to a six shoe brake with a 35 in. dia. drum.

Hydraulic-Pneumatic Automotive Brake

A two-step piston, with air operating on the large diameter and hydraulic fluid on the smaller step, enabled the Federal Fawick Corporation, Detroit, Michigan, to develop a combination hydraulic and pneumatic vehicle brake. Air-braking applied through a foot pedal is used for normal driving; hydraulic braking is applied by a hand lever in emergencies. A driver can actuate the two systems separately or simultaneously.

Fawick designed the Hydro-Air so that the brake and its operating mechanisms are totally contained within the drum. In this brake arrangement there are no air diaphragms, roto chambers, slack adjusters, camshafts or push rods. This permits cleaner and simpler axle design since there is no need for areas to support these parts or brackets to hold them secure. Also there are no areas left for installation or maintenance of such accessory parts.





CROSS-SECTION SHOWS path of two fluids in Hydro-air brake. Common source of fluid pressure actuates each shoe through stepped piston so that it contacts the drum with the same force as every other shoe in the braking system and at the same time. Mechanical linkage transmits the fluid pressure through piston and lever arm to force the brake shoe against the lining. Springs return piston to starting position.

EXPLODED VIEW shows all parts (except pistons). Parts are interchangeable and there are no "left or right hand" parts. Complete disassembly is accomplished by removal of the three pins that keep major sections together.

Fig. 1—Lug regarded as composed of laminations. To carry full calculated allowable load, all laminations in such a lug must carry an equal share.

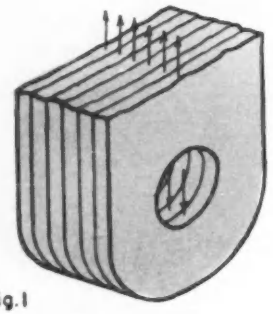


Fig. 1

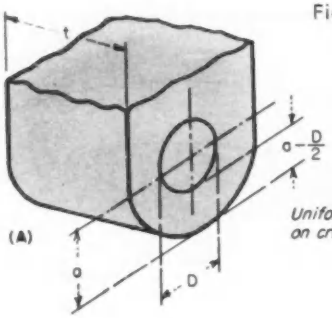


Fig. 2

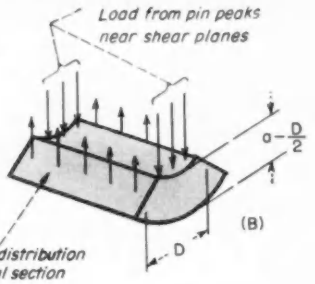


Fig. 2—(A) Geometry of a lug. (B) Action of "lug beam" in distributing pin load.

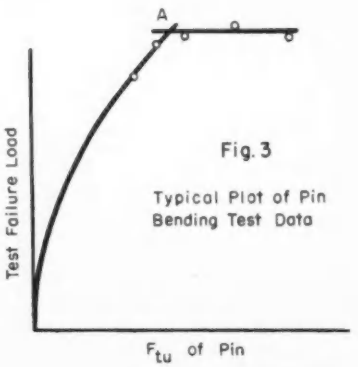


Fig. 3

Typical Plot of Pin Bending Test Data

Developments in the Analysis of

Method for determining the strength of lugs loaded obliquely or transversely.

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Structural Methods Group Engineer

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Structures Engineer
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A BASIC METHOD of analysis and procedure for the design of lug-pin combinations made of aluminum or steel alloys, with load applied axially, was given in the article "Analysis of Lugs and Shear Pins Made of Aluminum or Steel Alloys", *Product Engineering*, May 1950, p 113. A tension efficiency factor was introduced to account for stress concentration effects in producing net-section tension failures. Also, shear tearout and bearing were treated as a single mode of failure, and curves were given for predicting such failure in lugs of steel and aluminum alloy.

Since publication of the article referred to, methods of lug analysis have been further developed. These developments include a refinement in the previous method of determining pin or bolt adequacy with respect to bending failure and a method for determining the strength of a lug with transverse load.

The importance of providing adequate pin bending strength in lug-pin combination assemblies is often underestimated. Since pin bending failures are seldom observed either in static tests or in service, opposition has been expressed to the inclusion of any check of pin bending strength in a lug analysis. But even though pins are seldom observed to break, they can readily bend enough to precipitate failure in the lug.

In the authors' earlier article (Ref. 1) the bending strength of the pin or bolt was determined on the assumption of a uniform load distribution along the pin. This assumption was believed to be reasonably conservative, since there would be a tendency for

NOTATION AND NOMENCLATURE

In addition to the letter symbols indicated in Fig. 2, the following notation is used:

t = thickness of lug
F_{tu} = ultimate tensile strength of lug material
F_{tuw} = ultimate tensile strength of lug material with grain
F_{tus} = ultimate tensile strength of lug material across grain. When the plane of the lug contains both long and short transverse grain directions, F_{tus} is the smaller of the two values.
F_{ty} = tensile yield stress of lug material
F_{tyw} = tensile yield stress of lug material with grain
F_{tys} = tensile yield stress of lug material across grain. When the plane of the lug contains both long and short transverse grain directions, F_{tys} is the smaller of the two values.
F_{cy} = compressive yield stress of bushing material
P_l = applied limit load
P_u = applied ultimate load, this value is usually 1.5 P_l
P_y = applied yield load: Airforce and CAA equals P_l; Navy equals 1.15 P_l
M = applied bending moment in pin
α = angle between direction of loading on lug and the central plane of lug, deg
P'_u = allowable ultimate load
P'_{bru} = allowable ultimate load as determined by shear-bearing
P'_{bry} = allowable yield bearing load on bushing
P'_{tu} = allowable ultimate load as determined by tension
P'_{tru} = allowable ultimate load as determined for transverse loading (α = 90 deg)
P'_y = allowable yield load on lug
A_{br} = projected bearing area
A_t = minimum net section for tension
A_{tr} = weighted average area for transverse load
K_{br} = efficiency factor for shear-bearing
K_t = efficiency factor for tension
K_{tru} = efficiency factor for transverse load (ultimate)
K_{try} = efficiency factor for transverse load (yield)
C = yield factor
γ = pin binding moment reduction factor for peaking
r = $[a - (D/2)]/t$
R = load ratio in interaction equation
R_a = load ratio for axial load (α = 0 deg)
R_{tr} = load ratio for transverse load (α = 90 deg)

Lugs and Shear Pins

A refined procedure for predicting pin or bolt adequacy in bending failure.

the load to "peak up" near the shear planes and thus give a lower bending moment.

A recent combined theoretical and experimental investigation, however, shows clearly that the decrease in pin bending moment as a result of peaking is seldom more than 25 percent and usually much less. The exact value depends upon the lug geometry and the relative ultimate tensile strengths of lug and pin materials.

If a bolt and nut are used, of course, clamping action can reduce the bending moment. But usually this clamping action should not be relied upon. It is questionable whether the head of a standard shear type bolt is strong enough to give effective clamping; in addition, any gap between mating lugs tends to prevent effective clamping. In this discussion, it will be asssumed that such clamping action does not occur.

To visualize how a weak pin can precipitate failure of the lug, imagine the lug to be composed of laminations as shown in Fig. 1. For such a lug to carry its full calculated allowable load, all the laminations must carry an equal share.

If not strong enough to distribute the load equally to all the laminations, the pin will bend so that the load will concentrate on the outer laminations adjacent to the shear planes. Before the pin deforms enough to break, or even to be the obvious cause of failure, the outer laminations will stretch far enough to start a fracture. The inner laminations, however, either will have no load imposed upon them or will deform so little that only a small fraction of their possible load is developed. The lug therefore fails at less than its calculated allowable load.

This excessive deformation of the outer laminations occurs only with a

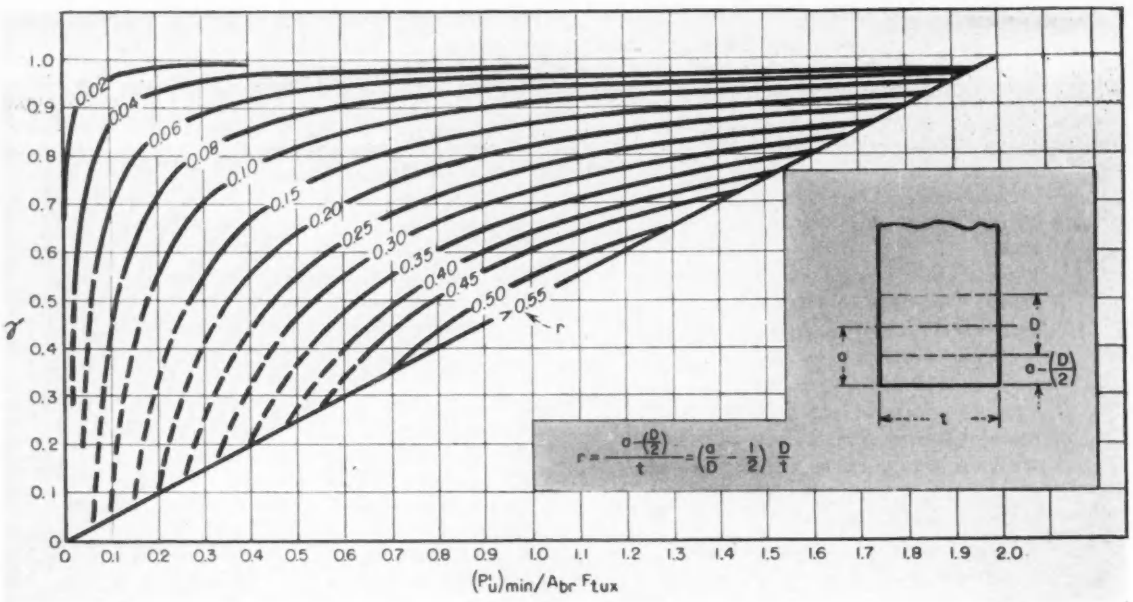


Fig. 4—Peaking factors for pin bending. Dash lines indicate region where these theoretical curves are not substantiated by test data.

weak pin. The elastic deflection of a strong pin is so small that the outer laminations can yield enough to maintain a nearly constant load distribution along the pin.

Even when the pin is loaded into the plastic range almost to its full modulus of rupture load, the pin deflection apparently is not enough to initiate failure of the laminated lug.

An actual lug differs only slightly from the laminated lug shown in Fig. 1. For the actual lug, the load from the pin does not have to be uniformly distributed across the lug thickness, as long as the stress on the shear-tearout and critical tension sections is uniformly distributed. A portion of the lug directly under the pin as shown in Fig. 2(B) can act as a beam and distribute the load. The extent to which the load can peak depends upon the strength of this "lug beam". The strength of this beam depends upon the geometry of the lug. The strength of this beam increases as the ratio of its depth to its length

$$[a - (D/2)]/t$$

becomes relatively larger.

This peaking effect is in addition to

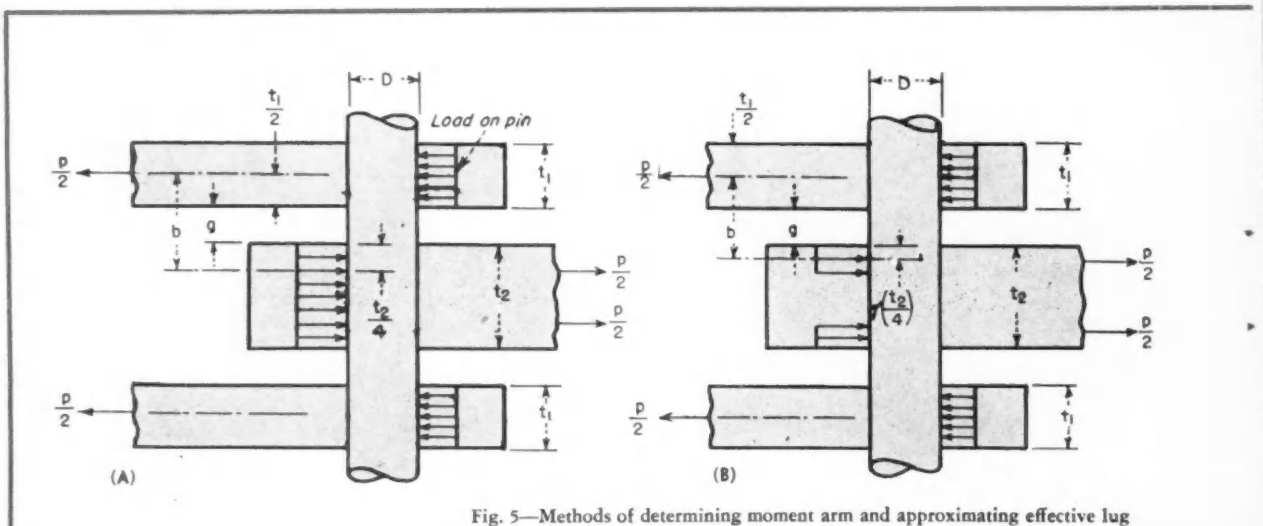


Fig. 5—Methods of determining moment arm and approximating effective lug

an effect that can be shown to occur when the lug is stronger than necessary. (Ref. 1). In brief, when the lug is "overstrong", the inner laminations are not needed to obtain lug strength. When the pin begins to bend, the inner laminations give up their load to the outer laminations, therefore, the inner laminations may be assumed inactive. Load is applied by the pin, then, only to the outer laminations.

Pin Bending Test Program

To demonstrate experimentally that pin bending could precipitate lug failure, and to evaluate the effectiveness of the "lug beam" in Fig. 2(B), a series of tests were performed using six geometries of lug pin combination. Five specimens, which were identical in every respect except for heat-treatment of the pin, were tested for each geometry.

A typical plot of pin bending test data is shown in Fig. 3. To the right of point *A*, the pins are so strong that lug failure is independent of the pin strength. After failure, these pins showed negligible permanent set. To the left of point *A*, as the pin heat-treatment was reduced, the failure load dropped off, and the pins after the tests showed increasing permanent bending deflection.

The theoretical shape of the curve to the left of point *A* can be shown to be a parabola, rather than a straight line, by noting that to the left of *A* the lug is "overstrong". This shape appeared to be confirmed by the tests although practical difficulties, such as entering the regime of pin shear failure, limited the number of test points that could be obtained along this part.

The reduction in bending moment as a result of peaking is indicated by the heat-treatment at point *A*, in comparison with the heat-treatment that would theoretically be required under the assumption of a uniform load distribution along the pin.

The effect of lug shape on peaking is shown by the curves in Fig. 4. The quantity γ given by these curves is a factor by which to multiply the bending moment arm in the inner lug to account for peaking. These curves were plotted from theoretically derived equations except for constants evaluated from the test data. In determining the curves, failures of the "lug beam" by bending, shear, and direct bearing were all considered.

No peaking can occur in the outer lugs unless a substantial bolt head or nut bears firmly on the lug. For an outer lug, the lug beam cannot be in equilibrium with peaking at the pin and a uniform load at the critical section except with bolt clamping.

Analysis Procedure for Pin Bending

The following procedure for determining pin bending strength incorporates the criteria for peaking discussed in the foregoing paragraphs and should be used in place of the method given in Ref. 1 for pin bending analysis.

1. Calculation of maximum bending moment in the pin that results from the applied ultimate load.

Obtain moment arm b as follows:

a. If it is desired to assume within an error of 0 to 25 percent a uniform distribution of loading on the pin and a gap exists between the inner and outer lugs as indicated in Fig. 5(A), the moment arm b is taken as

$$b = \frac{t_1}{2} + \frac{t_2}{4} + g$$

If there is no gap between the lugs, the moment arm b is taken as

$$b = \frac{t_1}{2} + \frac{t_2}{4} = (2t_1 + t_2)/4$$

b. If it is desired to take account of the reduction of pin bending that results from peaking, Fig. 5(B), the moment arm is obtained as follows:

Compute for the inner lug

$$r = [(a/D) - 1/2]\ D/t_2$$

Take smaller of P'_{bru} and P'_{tu} for inner lug as $(P'_u)_{min}$ and compute

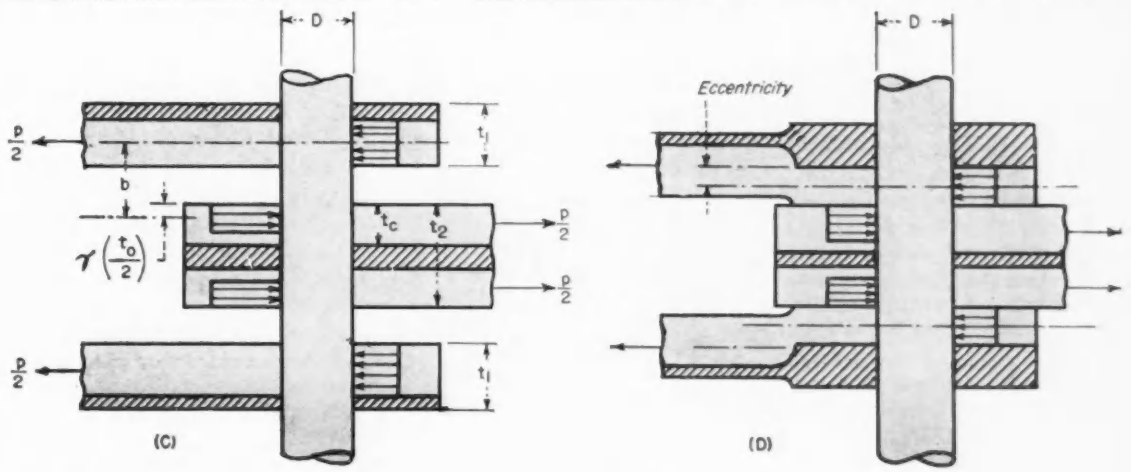
$$(P'_u)_{min}/A_{br}F_{tux}$$

Enter Fig. 4 with $(P'_u)_{min}/A_{br}\ F_{tux}$ and r to obtain the reduction factor γ for peaking, and calculate the moment arm b from

$$b = (t_1/2) + g + \gamma\ (t_2/4)$$

Note that the reduction for peaking only applies to the inner lug.

c. Calculate the maximum bending



thickness when calculating the pin bending moment and margin of safety.

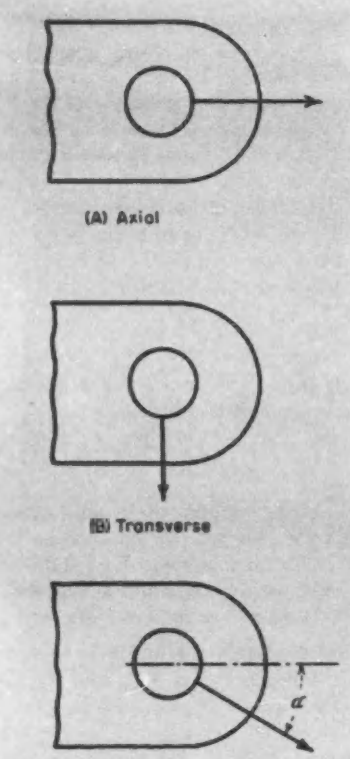
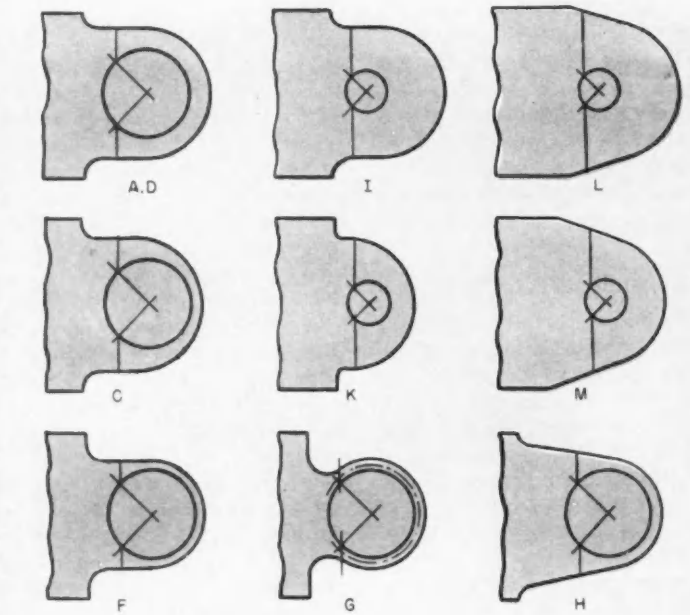


Fig. 6—Directions in which loads can be applied on lugs.



Lug B is intermediate between lugs A and C
Fig. 8 Lug J is intermediate between lugs I and K

Fig. 8 (Above)—Range of lug shapes covered by tests in which loads were applied either transversely or obliquely.

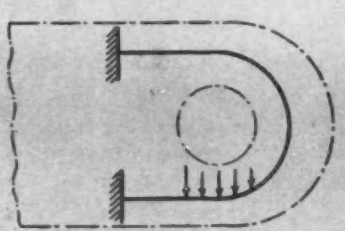


Fig. 7

Fig. 7—Unsatisfactory analytical method of assuming the lug to be an elastic frame.

Fig. 9 (Right)—Deformations in test lugs after failure. Part of these deformations may have occurred after fracture of the test lugs.

moment M in pin from the equation

$$M = P_u b/2$$

2. Calculate bending stress in the pin that results from M, assuming an My/I distribution.

3. Obtain modulus of rupture from ANC-5 or other authoritative source.

If the foregoing analysis should show inadequate pin bending strength and an excess of strength in the lug, it may be possible to take advantage of the excess lug strength to show adequate strength for the pin as follows:

4. Consider a portion of the lugs to be inactive, as indicated by the shaded area in Fig. 5(C). The portion of the thickness to be considered active may have any desired value sufficient to carry the load and should be chosen by trial and error to give approximately equal margin of safety for lugs and pin.

5. Recalculate all lug margins of safety, with allowable loads reduced in the ratio of active thickness to actual thickness.

6. Recalculate pin bending moment, M equal to $P_u b/2$, and margin of safety, using a reduced value of b obtained as follows:

a. Compute for inner lug, Fig. 5(C),

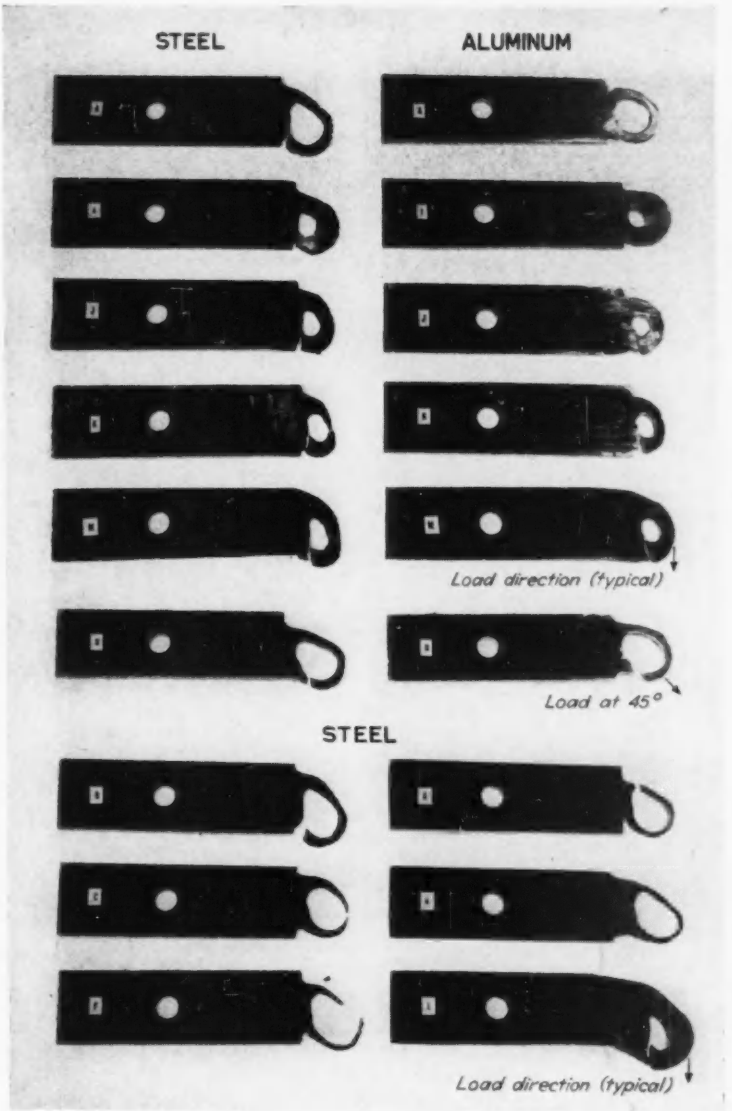
$$r = [(a/D) - 1/2]\, D/2t_a$$

b. Take smaller of P'_{bru} and P'_{tu} for inner lug, based upon active thickness, as $(P'_u)_{min}$ and compute $(P'_u)_{min}/A_{br}\, F_{tux}$.

c. Enter Fig. 4 with $(P'_u)_{min}/A_{br}\, F_{tux}$ and r to obtain the reduction factor γ for peaking.

d. Obtain ν as indicated in Fig. 5(C). Note that the reduction factor for peaking applies only to the inner lug.

This reduced b should not be used if the resulting eccentricity of load on the lug introduces excessive bending stresses in the adjacent structure, as shown in Fig. 5(D). In such events, the pin must be strong enough to withstand the loading shown in Fig. 5(B) to account for reduction of pin bending that results from peaking.



Strength of Lug in Transverse Loading

When load is applied axially to a lug by means of a closely fitting bolt or pin as shown in Fig. 6(A), the ultimate and yield strengths of the lug can be determined with reasonable accuracy by the method given in Ref. 1 or by other well known methods.

When the load is applied transversely or obliquely as in Figs. 6(B) and (C), however, no satisfactory method of analysis has been available. In the past, transversely loaded lugs have sometimes been treated as redundant elastic frames loaded by a uniform load from the pin as indicated in Fig. 7. But such an analysis is hopelessly laborious for routine stress analysis. Moreover, it is far from realistic. Even when stresses are in the elastic range, the load distribution is probably far from uniform since the comparatively rigid pin prevents bending deformation of the lug. And yielding of the lug prior to failure vastly changes whatever stress distribution might be correct for the elastic range. In both the elastic and plastic ranges, the load in the rim of the lug is probably carried far more by tension-strap effect than by bending.

As a forerunner to development of the method presented here, an attempt was made to develop a "plastic" or "limit design" type of analysis that would remove these deficiencies of the elastic analysis. But there remain uncertainties in the analysis and the labor required to reach a solution would be almost as great as that for the elastic analysis. Consequently, a purely empirical approach was indicated.

In a continuing effort to develop an accurate and less time consuming method, eighteen lugs of various shapes were made, Fig. 8, twelve of steel and six of aluminum alloy. The steel lugs were of 4130 steel, normalized, having an ultimate tensile strength of 98,000 psi, a tensile yield stress of 75,600 psi, and an elongation of 20 percent in 2 in. The aluminum lugs were of 24ST4 plate having an ultimate tensile strength of 73,000 psi, a tensile yield stress of 48,900 psi, and an elongation of 21 percent in 2 inches.

With loads applied either transversely or obliquely, these lugs were tested in the Lockheed Aircraft Corporation Research Laboratory for both ultimate and yield strength. The test lugs after failure are shown in Fig. 9. Note the wide variety of types of failure and the large degree of plastic deformation in many of the specimens. A part of this deformation, however, may have occurred after fracture.

From the test data, a single parameter was then found against which the test loads could be plotted with a minimum of scatter. The curves obtained give the allowable yield and allowable ultimate transverse loads of any proposed lug quickly and with good accuracy.

LUGS LOADED AXIALLY. To give some insight into how the lug-shape parameter for transverse load was obtained, a review of methods of lug analysis for axial load will be helpful.

Prior to the development of the methods given in the authors' earlier article lugs were ordinarily analyzed for three modes of failure: (1) Net section tension, Fig. 10; (2) Shear tearout, assuming all the load to be transmitted on "40 degree planes" as shown in Fig. 10; and (3) Bearing.

Work by Volkerson and Goschler (Ref. 2) indicated that modes (2) and (3) could be regarded as a single mode of failure and that for this mode, at least for lugs of steel and aluminum

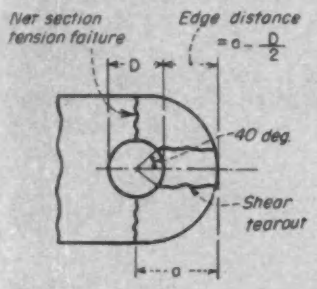


Fig. 10

Fig. 10—Net section tension failure under axial load, and shear tearout failure under axial load.

Fig. 11 — Shear-Bearing lug efficiency factors, ultimate. The family of curves in Fig. 13 are similar.

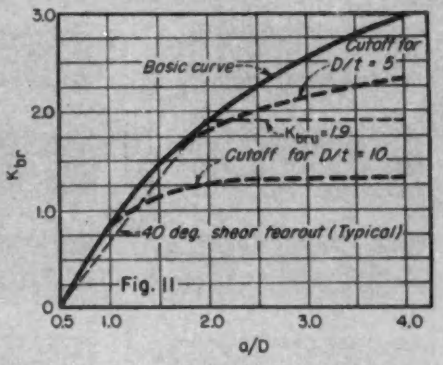
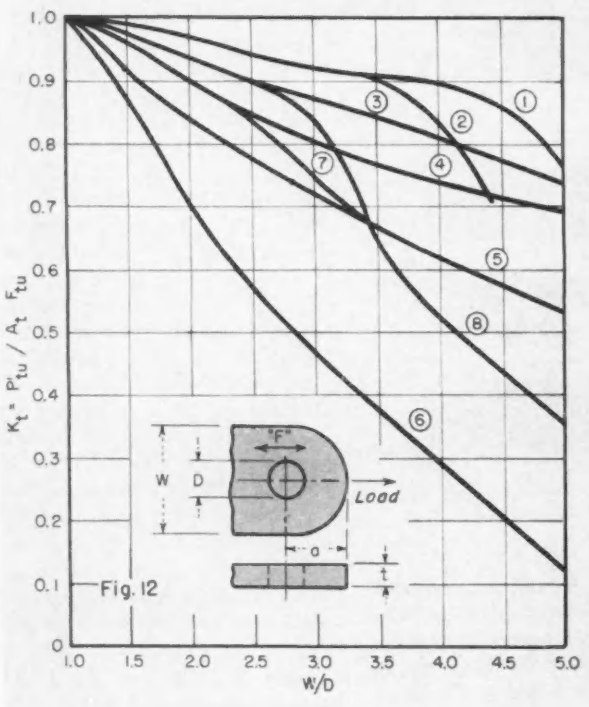


Fig. 12—Values of tension efficiency factors of lugs fabricated from typical steel and aluminum alloy materials produced by different manufacturing processes.



LEGEND. *L, T,* and *N* indicate grain in direction *F* in sketch:
L = longitudinal
T = long transverse
N = short transverse (normal)

CURVE 1:
4130 and 8630 steel
14S-T6 and 75S-T6 plate $\leqq$ 0.5 in. *(L, T)*
75S-T6 bar and extrusion *(L)*
14S-T6 hand forged billet $\leqq$ 144 sq in. *(L)*
14S-T6 and 75S-T6 die forgings *(L)*

CURVE 2:
14S-T6 and 75S-T6 plate $>$ 0.5 in., $\leqq$ 1 in.
75S-T6 extrusion *(T, N)*
75S-T6 hand forged billet $\leqq$ 36 sq in. *(L)*
14S-T6 hand forged billet $>$ 144 sq in. *(L)*
14S-T6 hand forged billet $\leqq$ 36 sq in. *(T)*
14S-T6 and 75S-T6 die forgings *(T)*

CURVE 3:
24S-T6 plate *(L, T)*
24S-T4 and 24S-T42 extrusion *(L, T, N)*

CURVE 4:
24S-T4 plate *(L, T)*
24S-T3 plate *(L, T)*
14S-T6 and 75S-T6 plate $>$ 1 in. *(L, T)*
24S-T4 bar *(L, T)*
75S-T6 hand forged billet $\geqq$ 36 sq in. *(L)*
75S-T6 hand forged billet $\leqq$ 16 sq in. *(T)*

CURVE 5:
195T6, 220T4, and 356T6 aluminum alloy casting
75S-T6 hand forged billet $>$ 16 sq in. *(T)*
14S-T6 hand forged billet $>$ 36 sq in. *(T)*

CURVE 6:
Aluminum alloy plate, bar, hand forged billet, and die forging *(N)*. Note; for die forging, *N* direction exists only at parting plane.
75S-T6 bar *(T)*

CURVE 7:
18-8 stainless steel, annealed

CURVE 8:
18-8 stainless steel, full hard. Note; for ¼, ½ and ¾ hard, interpolate between Curves 7 and 8.

alloy, the failure load is predicted by the single equation

$$P'_u = K_{br} A_{br} F_{tu}$$

where:

P'_u = failure load (ultimate)
K_{br} = shear-bearing "efficiency factor", or ratio of bearing stress at which failure occurs to ultimate tensile strength of material
A_{br} = projected bearing area
F_{tu} = ultimate tensile strength of lug material

Over a range of lug shapes covering nearly all lugs found in practice, K_{br} depends only on the ratio a/D (Fig. 10). This ratio is a nondimensional measure of the edge distance. The ratio D/t also affects the shear-bearing efficiency factor K_{br} but only for very large values of D/t or a/D, and can usually be ignored.

The curve of K_{br} as a function of a/D, together with two of the cutoff lines for large D/t as shown in Fig. 11. Except that much of the detail has been omitted, the curves of Fig. 11 are similar to the family of curves shown in Fig. 13, which together with Fig. 12, has been presented previously in the authors' previous article (Ref. 1). These curves, Fig. 11, especially the "envelope" curve for normal D/t,

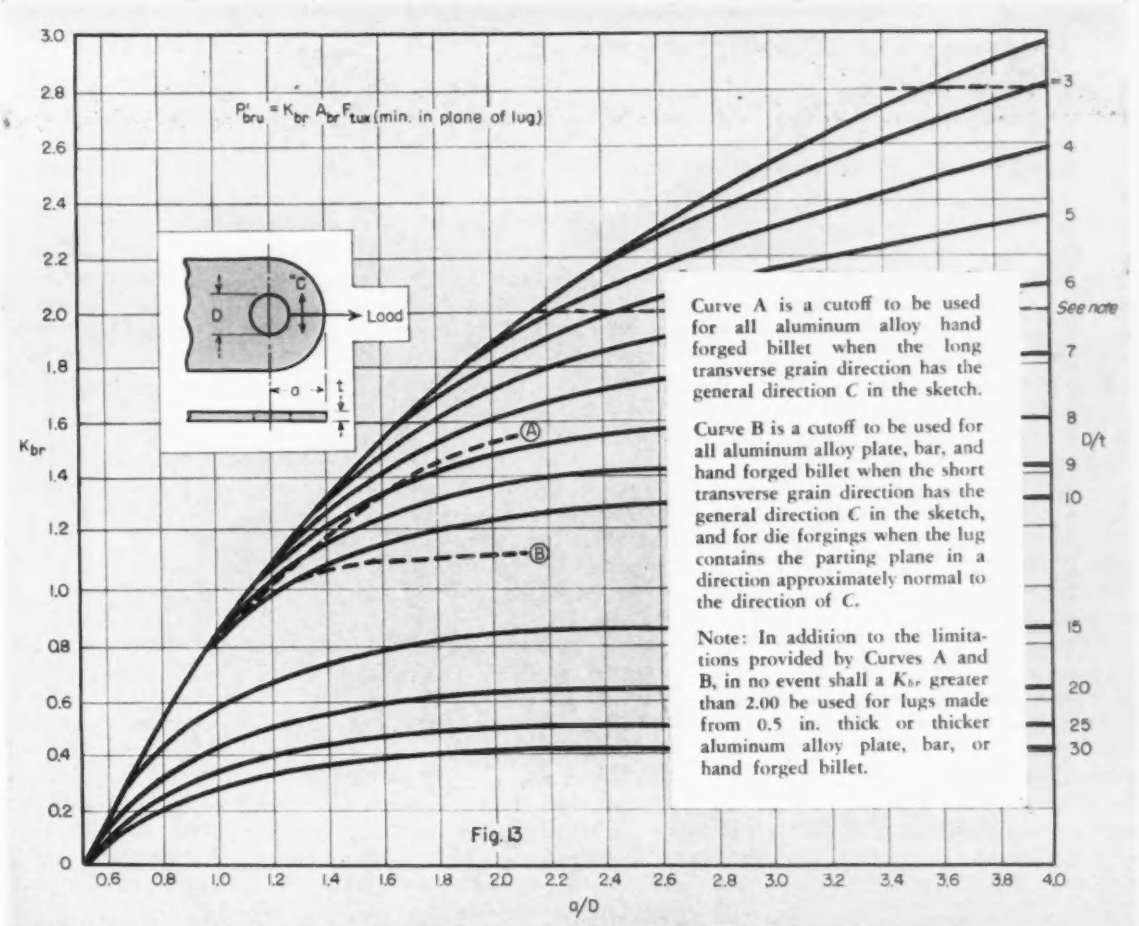

$P'_{bru} = K_{br} A_{br} F_{tux}$ (min. in plane of lug)
K_{br}
a/D
D/t
Load
Curve A is a cutoff to be used for all aluminum alloy hand forged billet when the long transverse grain direction has the general direction C in the sketch.
Curve B is a cutoff to be used for all aluminum alloy plate, bar, and hand forged billet when the short transverse grain direction has the general direction C in the sketch, and for die forgings when the lug contains the parting plane in a direction approximately normal to the direction of C.
Note: In addition to the limitations provided by Curves A and B, in no event shall a K_{br} greater than 2.00 be used for lugs made from 0.5 in. thick or thicker aluminum alloy plate, bar, or hand forged billet.
See note
Fig. 13

Fig. 13—Curves of efficiency factors for shear-bearing of lugs of different dimensional proportions.

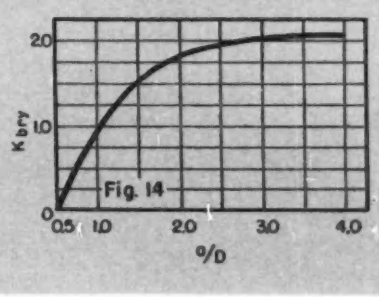


Fig. 14—Factors for calculating yield axial loads attributable to shear-bearing of lug and pin.

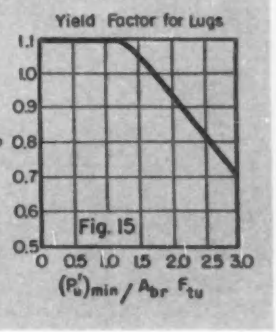


Fig. 15—Factors for obtaining the allowable yield load for a lug in terms of allowable minimum load.

have been substantiated by a multitude of tests. Fig. 11 also includes a line that shows the allowable ultimate load based upon the 40 deg shear tear-out criterion for a typical shape of lug. This curve, together with the usual ultimate bearing allowable of 1.9 F_{tu}, gives a composite curve roughly the same as Volkerson's curve but more conservative over much of the range of a/D. It can be shown that the K_{br} curve given also precludes "hoop tension" failure at the tip of the lug.

Yield axial loads attributable to shear-bearing are given by an equivalent expression,

$$P'_y = K_{bry} A_{br} F_{ty}$$

where K_{bry} is given by Fig. 14. Yield loads given by Fig. 14 are identical to those given by Fig. 15 (which also has been previously presented in Ref. 1) used in conjunction with Fig. 13.

SHAPE PARAMETER FOR TRANSVERSE LOAD. By analogy with the allowable shear-bearing load for axially loaded lugs, it is convenient to express the allowable ultimate transverse load by means of the formula

$$P'_{tru} = K_{tru} A_{br} F_{tu} \qquad (1)$$

in which K_{tru} is a function only of the shape of the lug.

Only the edge-distance dimension is pertinent in obtaining the allowable shear-bearing axial load, but more dimensions are necessary to obtain the allowable transverse load, for two reasons: (1) More modes of failure must be accounted for by a single criterion; and (2) with transverse load there are, in effect, alternate load paths. For example, a deficiency in shear or bending strength under the load can be compensated for by an excess of hoop strap strength around the rim.

Where A_1, A_2, A_3 and A_4 are cross-sectional areas measured as indicated in Fig. 16 and

$$A_{av} = \frac{6}{(3/A_1)+(1/A_2)+(1/A_3)+(1/A_4)}$$

the parameter A_{av}/A_{br} has been found suitable to represent the lug shape. To make it applicable, at least approximately, to lugs of non-constant thickness, areas are used in this parameter rather than linear dimensions such as were used in the analysis for axial load.

The averaging is on a reciprocal basis to give reasonal results when a single area is disproportionately large or small. When one area is appreciably larger than the others, further increase of that area should not give much increase of strength, therefore, the formula satisfies this condition. Furthermore, when any one area is very small, it represents a weak link in the chain and the allowable load as measured by A_{av} should approach zero; this condition too is satisfied.

The coefficient 3 in the term $3/A_1$, was required to give the least scatter of test data. This requirement is reasonable since A_1 is normally larger than the other A terms and a larger coefficient is required to give equal effective weighting; also, since the area A_1 is at the root of the cantilever portion of the lug, it probably carries most of the load.

ULTIMATE FAILURE LOAD. Curves of the efficiency factor K_{tru} as a function of the parameter A_{av}/A_{br} are shown in Fig. 17, together with the substantiating test points, for the two materials used in the tests.

To obtain the allowable ultimate transverse load for any given lug, it is only necessary to evaluate A_{av}/A_{br}, read K_{tru} from Fig. 17 for the appropriate lug material, and substitute in Eq (1). Care should always be taken, of course, to assure that the lug does not have peculiarities of shape outside the range, Fig. 8, of the lugs tested.

No satisfactory theory has been devised to explain why the two curves given are different and to extend these data to other materials. Hence test data for other materials are desired. Until such data are available, it is suggested that the curves of Fig. 18 be used for design. These curves are based upon a crude theory. They indicate rather large reductions of strength for materials of low ductility, such as aged aluminum alloys and high heat-treat steels, and also for materials having a low ratio of F_{ty} to F_{tu}, such as the casting alloys. Although some such reduction is expected, the curves appear to overestimate the magnitude of the reduction.

YIELD LOAD. The parameter A_{av}/A_{br} used to correlate test data on ultimate load also correlates yield data satisfactorily.

The yield load is given by

$$P'_{try} = K_{try} A_{br} F_{ty}$$

where K_{try} is given as a function of A_{av}/A_{br} in Fig. 19. P'_{try} is the load at which the permanent set is 2 percent of the diameter, and F_{ty} is the 0.2 percent offset yield strength of the material. It can be readily seen from the test data that are plotted in Fig. 19 covering the range of lug shapes that were tested that one curve fits the test points satisfactorily for both lug materials.

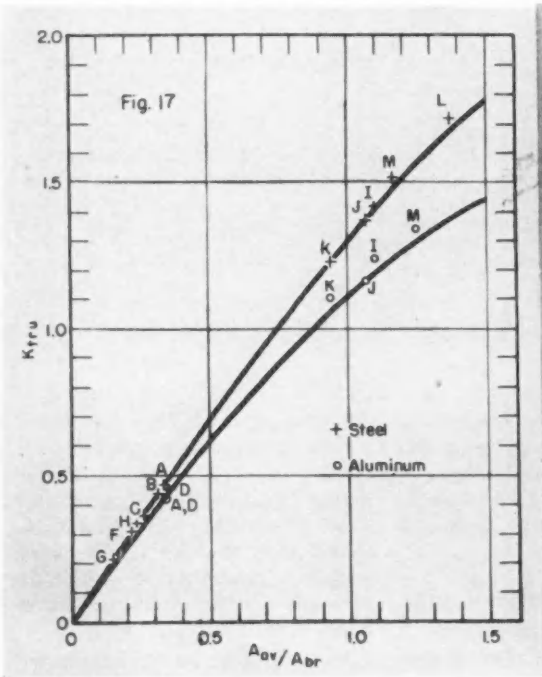
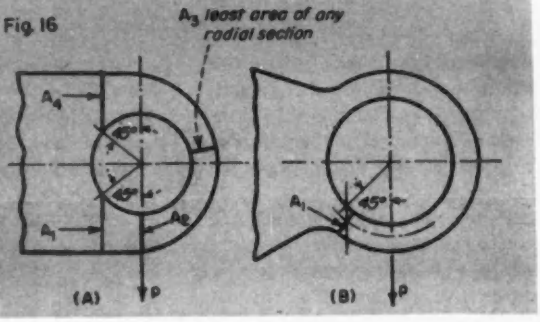
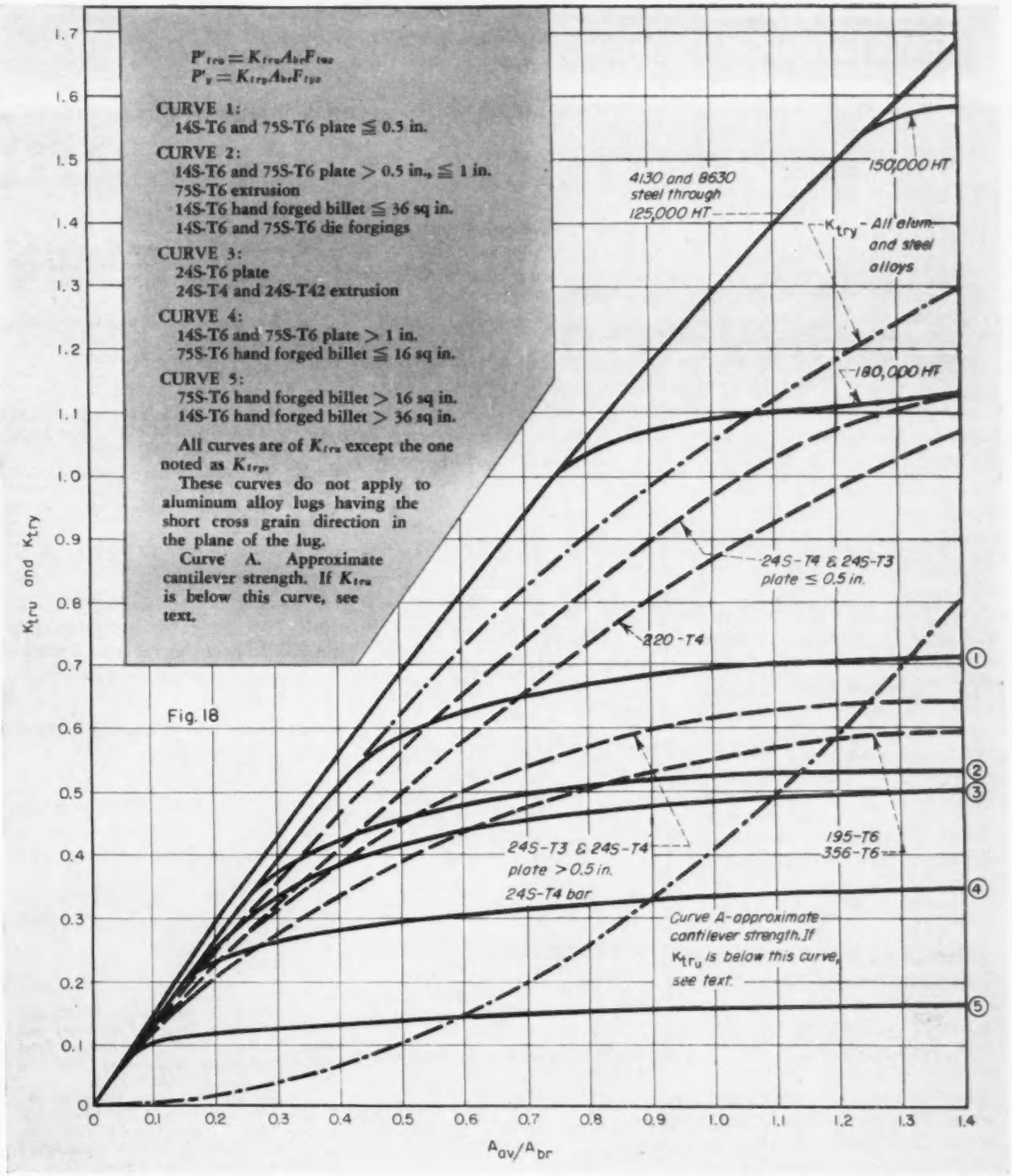


Fig. 16 (Below)—Locations of cross-sectional areas that are measured to obtain a weighted average of areas that is representative of the lug shape.

Fig. 17 (Left)—Efficiency factor for transverse load, ultimate, with substantiating test points for the range of lug shapes shown in Fig. 8.

Fig. 18 (Right)—Lug efficiency factors for transverse load and various materials.




$P'_{tru} = K_{tru} A_{br} F_{tuo}$
$P'_{y} = K_{try} A_{br} F_{tyo}$
CURVE 1:
14S-T6 and 75S-T6 plate ≦ 0.5 in.
CURVE 2:
14S-T6 and 75S-T6 plate > 0.5 in., ≦ 1 in.
75S-T6 extrusion
14S-T6 hand forged billet ≦ 36 sq in.
14S-T6 and 75S-T6 die forgings
CURVE 3:
24S-T6 plate
24S-T4 and 24S-T42 extrusion
CURVE 4:
14S-T6 and 75S-T6 plate > 1 in.
75S-T6 hand forged billet ≦ 16 sq in.
CURVE 5:
75S-T6 hand forged billet > 16 sq in.
14S-T6 hand forged billet > 36 sq in.
All curves are of K_{tru} except the one noted as K_{try}.
These curves do not apply to aluminum alloy lugs having the short cross grain direction in the plane of the lug.
Curve A. Approximate cantilever strength. If K_{tru} is below this curve, see text.
Fig. 18
4130 and 8630 steel through 125,000 HT
150,000 HT
K_{try} - All alum. and steel alloys
180,000 HT
24S-T4 & 24S-T3 plate ≤ 0.5 in.
220-T4
24S-T3 & 24S-T4 plate > 0.5 in.
24S-T4 bar
195-T6
356-T6
Curve A-approximate cantilever strength. If K_{tru} is below this curve, see text.
K_{tru} and K_{try}
A_{av}/A_{br}

Oblique Loads

A convenient approach to the strength of lugs under oblique load is to resolve the applied load into axial and transverse components (to be designated by subscripts "a" and "tr") and obtain an interaction curve relating them. In the absence of extensive test data, it is reasonable to assume the interaction equation to be

$$R_a^m + R_b^m = 1$$

in which R_a and R_b are ratios of applied to allowable loads in the indicated directions. On the basis of only two tests, the exponent m may be assigned a value of 1.6 as being safe for both ultimate and yield loads for both the aluminum and steel alloys used in the test specimens.

Analysis Procedure

CASE I—TRANSVERSE LOADING (a = 90 DEG)

A. Obtain the areas A_1, A_2, A_3, and A_4 as follows:

1. A_1, A_2, and A_4 are measured on the planes indicated in Fig. 16(A) (perpendicular to the axial centerline), except that in a necked lug A_1 and A_4

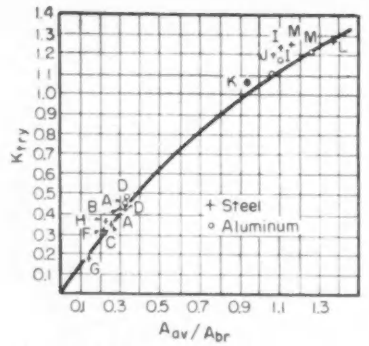


Fig. 19—Efficiency factor for transverse load, yield, with substantiating test points for range of shapes shown in Fig. 8.

as shown in Fig. 16(B) should be measured perpendicular to the local centerline.

2. A_3 is the least area on any radial section around the hole.

3. Since the choice of areas and the method of averaging has been substantiated only for lugs of the shapes shown in Fig. 8, thought should always be given to assure that the areas A_1, A_2, A_3, and A_4 adequately reflect the strength of the lug. For lugs of unusual shape (for example, with sudden changes of cross section), an equivalent lug should be sketched as shown in Fig. 20 and used in the analysis.

Obtain the weighted average of these areas using the formula

$$A_{av} = \frac{6}{(3/A_1)+(1/A_2)+(1/A_3)+(1/A_4)}$$

B. Compute: $A_{br} = Dt$, and A_{av}/A_{br}

C. Determine allowable ultimate load P'_{tru} for lug failure:

1. Obtain K_{tru} from Fig. 18
2. $P'_{tru} = K_{tru}\, A_{br}\, F_{tux}$

Note: The curve for "Steel through 125,000HT" in Fig. 18 agrees closely with test data. Curves for all other materials have been obtained by the best available means of correcting for material properties and may possibly be very conservative in some places.

In no case should the allowable transverse load be taken as less than that which could be carried by cantilever beam action of the portion of the lug under the load (Fig. 21). The load that can be carried by cantilever beam action is indicated very approximately by Curve (A) in Fig. 18; should K_{tru} be below Curve (A), a separate calculation as a cantilever beam is warranted.

D. Determine allowable yield load P'_y of lug.

1. Obtain K_{try} from Fig. 18.
2. $P'_y = K_{try}\, A_{br}\, F_{tyx}$

E. Determine allowable yield bearing load P'_{bry} on bushing.

Take A_{brb} as the smaller of the bearing areas of bushing on pin or bushing on lug. (The latter may be the smaller as a result of external chamfer on the bushing.)

$$P'_{bry} = 1.85\, F_{cy}\, A_{brb}$$

F. Investigate pin shear in usual manner.

G. Investigate pin bending as discussed in the foregoing paragraphs included under the sub-head "Analysis Procedure for Pin Bending" modified as follows:

Take $(P'_u)_{min} = P'_{tru}$
In the equation
$r = [a - (D/2)]/t$

use for the $[a - (D/2)]$ term the edge distance at $\alpha = 90$ deg.

H. Pin yield and bushing ultimate are never critical in aircraft practice.

CASE II—OBLIQUE LOADING ($0 < \alpha < 90$ DEG)

A. Resolve the applied load into axial and transverse components and obtain the lug ultimate and yield margins of safety from the interaction equation:

$$R_a^{1.6} + R_{tr}^{1.6} = 1$$

or Margin of Safety =

$$\frac{1}{(R_a^{1.6} + R_{tr}^{1.6})^{0.625}} - 1$$

where, for ultimate load

R_a = (Axial component of applied ultimate load) divided by (Smaller of P'_{bru} and P'_{tu} from Figs. 12 and 13).

R_{tr} = (Transverse component of applied ultimate load) divided by (P'_{tru} from Analysis Procedure for α = 90 deg)

and for yield load

R_a = (Axial component of applied yield load) divided by (P'_y from Figs. 12, 13 and 15)

R_{tr} = (Transverse component of applied yield load) divided by (P'_{try} from Analysis Procedure for α = 90 deg)

B. Investigate yield of bushing as in Case I, step E.

C. Investigate pin bending as discussed in the foregoing paragraphs included under the sub-head "Analysis Procedure for Pin Bending" modified as follows:

Take $(P'_u)_{min} = P_u/(R_a^{1.6} + R_{tr}^{1.6})^{0.625}$
In the equation
$r = [a - (D/2)]/t$

use for the $[a - (D/2)]$ term the edge distance at the value of a corresponding to the direction of load on the lug.

D. Obtain bushing and pin margins of safety in the same way as with a equal to 90 degrees.

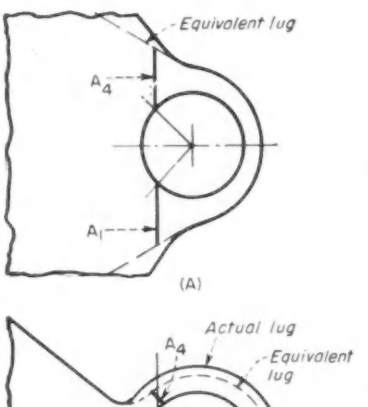


Fig. 20—Equivalent lugs for lugs of unusual shape.

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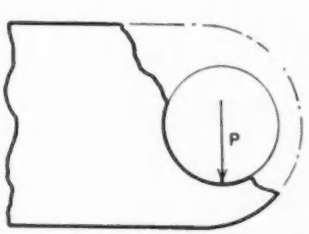
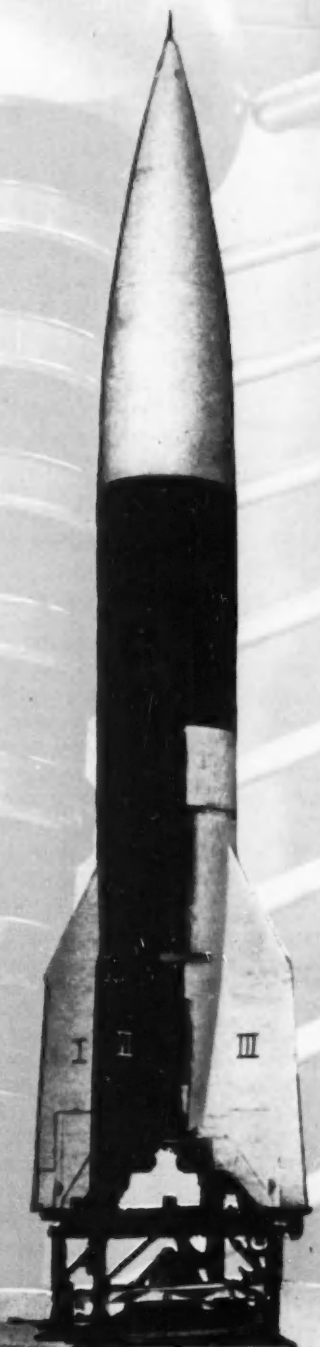


Fig. 21—Cantilever beam action of the portion of the lug under load.

Insuring Your PROGRESS THROUGH RESEARCH



PRODUCT ENGINEERING • JUNE 1953

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MANAGEMENT PROBLEMS IN A RESEARCH ORGANIZATION

PERSONNEL

Basic Policy Decisions	Basic organization structure; number, responsibilities, and relationships of supervisors, staff, research workers, etc.; relationship of laboratory to other parts of the company; methods of communication.
Planning for Future Periods	Matching work to be done with abilities and interests of men available.
Operations	Selection, promotion, dismissal, training; monetary and non-monetary rewards; creation and maintenance of atmosphere; supervision and motivation.
Checking Up	Measuring performance of individuals; finding out what they have been doing and how well they have been doing it.

ORGANIZING

ERHARDT C. KOERPER
Consultant
Milwaukee, Wisconsin

RESEARCH is a frame of mind that makes for "profitable obsolescence". Its competitive use is one of industry's most powerful weapons for economic survival. Recurring business failures bear witness to the fact that customers are constantly changing their allegiance from one supplier to another. Products are preferred for one or more of many reasons, including better function, lower price, more pleasing appearance, simpler maintenance and longer life. These and other factors determine the continued success of a company's product and must be constantly considered and analyzed by industrial research groups.

The national investment in scientific research and development totaled more than 3.5 billion dollars in 1952. This is more than four times the yearly expenditure in 1942. Evidence of the value of research to industry is the fact that two-thirds of the total annual cost is incurred by private industry in some 3,000 laboratories employing more than 300,000 people.

Properly integrated and directed, research pays off with big dividends throughout industry and commerce. Among the many thousand profitable long-term projects, there are three that illustrate the size of these research dividends. Each of the following resulted in the creation of many new vigorous companies and many more improved products:

(1) Increased productivity of machine tools by 3.5 times during the last 15 years.

(2) Synthetic rubber with annual sales of half a billion dollars only 10 years after its inception.

(3) The electronics industry in which annual sales have grown from less than one billion dollars to more than five billions since World War II.

Types of Research

Effective research is based on clear incisive thinking. Often researchers try to cover too wide a field in an effort to obtain early results. Others focus their efforts only on the narrow, immediate problems and in so doing, overlook profitable areas. A program based on a balance between long- and short-term projects and the various types of research is the most practical approach.

In its systematic and continuous search for new knowledge, research should have its primary classification on the type of thinking involved rather than whether it be so-called fundamental or applied. For this purpose, the following simplified definitions are sufficient:

Pure Research is exploration for new ideas of an abstract nature. Generally this type of work is carried on in the laboratories of large industries, the universities and government. Here are born the new ideas that have a significant influence on industrial applications.

Basic Research is the development of new materials and processes. Here the theories and ideas developed in pure research are applied to create new materials such as special metallic alloys, new nonmetallic materials and more economical fabricating processes. As the objectives of these studies become more specifically defined, the more reason to classify such activities as *applied research.*

Product Research and Development is the improvement of current products and the development of new products, generally with the aid of ideas and processes developed in pure and basic research. A new car, washing machine or machine tool is a typical example.

Integrating the Research Program

The most effective research program is one that is continuous and fully integrated into the company's marketing and production policy. Aside from work on projects that will be of use in the immediate future, an appreciable part of the research effort should be conducted sufficiently in advance of immediate needs to insure a continuous flow of basic ideas into products that are commercially desirable.

Key Factors in the Research Function

Personnel. There is no more important factor in good research than the personnel doing it. These men must be carefully selected not only for their specific technical knowledge, but also for their mutual compatibility. Their training must integrate the objectives of the company. They must know that their work is important and of a continuing nature as a partial incentive for creative effort.

FACILITIES	TECHNICAL WORK	MONEY
Size and type of facilities; centralized vs decentralized research; location with respect to other departments; character and amount of service to be furnished research workers; location of service facilities.	Scope, size and character of research and development work; areas to be investigated; proportion of work to be done inside the laboratory, elsewhere in the company and outside the company, patent and license policy.	Determination of total amount to be spent on research and development; method of providing funds.
What items of equipment should be added, repaired or discarded; amount and kind of service work required.	What projects are to be worked on; how much emphasis should be devoted to each.	Preparation of financial budget; translation of plans into financial terms.
Responsibility for custody and use of equipment; operation of equipment pools; assignment of space; relationships between technical organization and service organization.	Problems associated with actually doing research work; communication of ideas, progress, etc., within the laboratory and to others; coordination of related work; transition to development and production.	Recording what is spent; various accounting problems; specific restrictions on the expenditure of funds.
Appraising usefulness of various types of equipment; finding out whether service departments are providing proper service.	Evaluation of rate of progress and probability of success; decisions to expand, contract, continue or stop work on a project.	Use of financial information as a basis for checking performance.

Division of Research, Harvard Business School

for Industrial Research

The research director must be primarily an organizer, able to work with people and to inspire them to work aggressively with each other. He must clearly interpret the company thinking into an economic research program. To do this, he must not only know the company policies but feel its tempo.

Facilities. Whether the research laboratory be a small room or a multimillion dollar research center, similar policy decisions must be made and reviewed. Chief among these are the location of facilities, flexibility, provision for expansion and working conditions. These have a decided effect on the research staff and help protect the company's original investment in the research function.

Projects. There are numerous projects suited to research in any company. The difficulty is deciding which projects should come first. These decisions are based on such things as a survey of competitive products, need for expanding the field of a product's application and availability of new or promising ideas, materials or processes. Projects to be pursued must be collected, evaluated and integrated into a balanced research program and efforts directed into the most profitable channels through the use of simple follow-up procedures.

Money. It is only realistic to have a budget for the expenditure and the control of research funds. Though the results of research are difficult to predict and therefore costs difficult to fully justify, management should be kept informed of calculated risks in order to assure proper and consistent emphasis on desired results.

Organizational Structure. Research and development organizations should be set up on a functional line rather than be blocked into confining compartments of an organization chart. Too often formal organization reduces personnel utilization and discourages originality by making men channel conscious. Research is done in areas not in channels. And like academic freedom, communications are important in a research organization. They should be based on a two-way system to include other company departments. If narrow organizational channels are imposed, the free flow of information and independent creative thinking are discouraged. Red tape hog-ties aggressive project development, long channels of communication drown personal initiative and lack of specific action on sound recommendations breeds indifference.

Supplementary Source of Ideas

If a company wants to catch up on and keep abreast of a subject, several sources of data are available. These include libraries, patent literature and consultants. When a company supplements its research function by contracting with "outside" groups, there are three alternatives: Commercial laboratories, independent research institutes or university research foundations can be commissioned for specific projects; reports based on government research can be obtained; or patents can be licensed.

Patent Licenses. There are many advantages to obtaining through licensing agreements the rights and privileges that go with a patent. Companies both large and small become parties to such agreements in order to have a marketable product, or supplement an established line of products or services.

Contract Research. The rapid growth of commercial laboratories, independent research institutes and university research foundations is ample testimony to the great volume of contract research. By reason of their technical staffs and specialized facilities, these sources of research in all its forms are liberally used by industry for a wide variety of purposes. For an annual expenditure of $10,000 to $15,000 the small company, as well as the large corporation with its own laboratory, can engage in profitable research.

Government Research Data. When it is realized there are more than fifty government-owned laboratories, it is not hard to visualize how many research projects reports are compiled each year. For its own use and *for the benefit of industry*, the government maintains the Office of Technical Services and the Patent Office.

The seven articles that follow elaborate on the key aspects of conducting an "inside" or "outside" research program, namely: personnel, facilities, projects and budgets for the "inside" jobs; patent licensing, contract research and government laboratory data as "outside" sources.

Obtaining and Keeping RESEARCH PERSONNEL

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The most valuable asset in a research operation is qualified personnel, and the product of such people is thinking that can be translated into new products and services. An effective research personnel program must, therefore, stress the selection of scientists and engineers who can think, the development of an atmosphere conducive to thinking, and the provision of incentives to stimulate thinking. Such a personnel program is essential at all times, but, because of the current shortage of scientists and engineers, the importance of effective personnel selection and utilization is greatly amplified. To assist in solving these very real problems, this article discusses methods of procuring, indoctrinating, and utilizing research personnel.

Manpower Shortage

There is today and there will be in the years just ahead, a critical shortage of scientific manpower in this country. Thousands of newspaper stories and editorials, technical journal articles, pamphlets, and even books have forcefully brought this matter to the attention of the general public as well as civilian and government leaders.

The unprecedented demand for competent scientists and research engineers is primarily the result of the expanded Armed Forces defense program and the growing personnel needs of new industries created by the research of yesterday. While the staffing of new and expanding companies is normal and legitimate, the necessity of taking young engineers into the Armed Services in great numbers is abnormal but essential. Selective Service headquarters has repeatedly stated that new supplies of manpower must be tapped if the future requirements of the Armed Forces are to be met. This policy has been borne out when it is noted that it has become increasingly more difficult for employers to secure deferments for their scientific personnel—it even applies to graduate engineers working in key positions on defense projects. This fact alone makes it evident that all users of technical manpower must make sure that everyone on their staff is utilized effectively.

Personnel Functions in Research Groups

All types of research work require a person who is well trained in one or more specific fields. He must have creative ability, imagination and originality of a high order. Because of this personal makeup, the research engineer tends to be an individualist who resents regimentation. He is happy and contented when treated as an individual and an integral part of the organization in which he works. In his particular position, he likes to have the feeling that he is able to develop personally and professionally; that he has freedom of action at all times.

Normal personnel functions, such as indoctrination, remuneration and advancement, are, therefore, inadequate in the handling of research and development engineers. Management can provide the required "extras" in various ways. Frequent seminars facilitate extensive exchange of information; attendance at society meetings keeps researchers abreast of professional developments; inservice training courses familiarize inexperienced personnel with the thinking and techniques of specialists in the organization; and a college training program encourages personnel to take advanced studies. Seminar and training programs assure an informed progressive group capable of applying modern techniques to problems and of meeting emergencies as they arise in everyday work.

Working conditions conducive to creative thinking should also be provided. A quiet office that is bright and clean is a modest investment, but such a facility can double or treble the output of an engineer who has been working under improper conditions. And, in these days of confusion, provision should be made for reducing the personal worries of the individual. For example, advice could be given regarding the procurement of sound information on housing and minor legal matters, and on school and banking facilities.

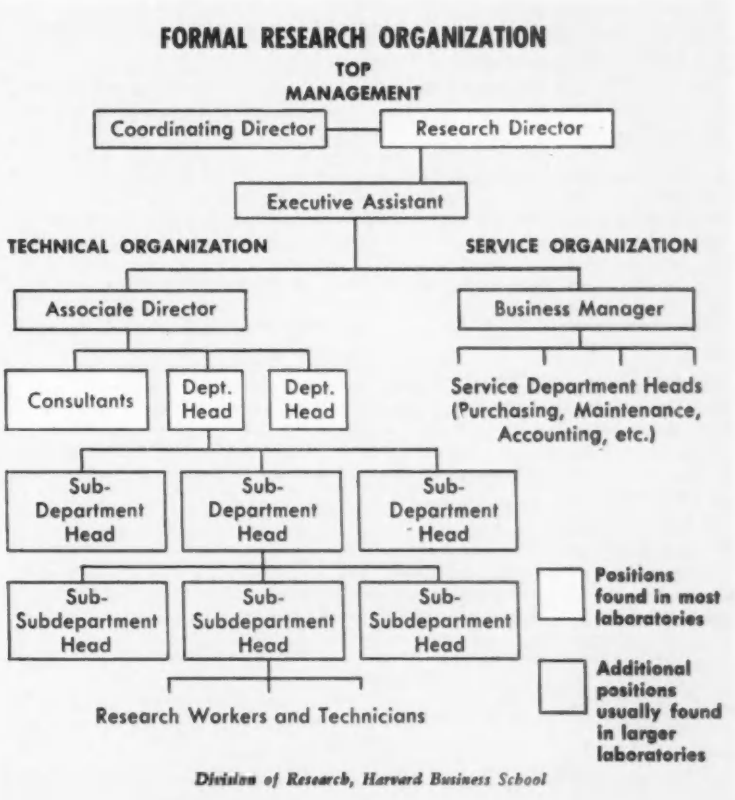
Determining Personnel Requirements

The determination of engineering personnel requirements for a given operation is essentially a planning and organization program. The first step of such a program is to define clearly the objectives of the research program and an acceptable time schedule for meeting these objectives. The schedule may be governed by budget allocations, or according to a predicted optimum rate of progress established by the research director. With an intimate knowledge of the program and the schedule, the research staff can estimate, with an accuracy determined only by experience, the number of man-hours of effort of different levels of talent required in different technical fields. From this information, specifications for a position or a series of positions can be developed. These specifications should be written and include a succinct definition of the duties of the position, its location in the organizational structure, the number and type of persons supervised, the nature of personal contacts, the nature of instrumentation and equipment utilized.

If the research operation is a new one, the specifications should be carefully analyzed and arranged into a position classification system. This system affords a method of allocating duties and responsibilities among various positions, and, in addition, serves several purposes. First, the position specifications or descriptions, which constitute the system, are invaluable to the recruiter because they are a written record of the characteristics of personnel he has to recruit. Second, the description outlines for a new incumbent of a position the nature of his particular responsibilities, and prevents misunderstandings between himself and his supervisor. Finally, the system can serve as an excellent basis for a salary plan and for promotions.

Accumulation of Applications

Today positions are seeking men. To find quality research personnel in such a market, employers must plan aggressive recruitment programs. No single recruitment technique can fill all positions, or one particular position. A planned program should, therefore, incorporate several methods for accumulating applications from candidates for research positions. *Personal Contacts.* By far the best method of accumulating applications is through the efforts of the members



MEASURING EFFECTIVENESS OF RESEARCH PERSONNEL

C. G. SUITS

Vice-President and Director of Research, General Electric Company

The evaluation of research scientists is complicated by many factors. In contrast to easily-defined jobs in which tangible results capable of ready evaluation can be expected in a relatively short time, research positions have qualifications that are less readily specified. The end products of research are often intangible and, hence, less susceptible to immediate and precise evaluation. This uncertainty is inherent when dealing with ideas, clarifying new principles, and amassing new scientific information.

It is the over-all judgment of an informed management regarding the relative value of an individual's contribution to a project, and the results produced by the project, that constitutes the soundest basis of evaluation for purposes of remuneration. While absolute standards may be a partial measure of the tangible portion of a scientist's output, these standards do not provide a complete measure of the tangible results. They supply but a clue to the much more important intangible aspects of his accomplishments.

Some of the tangible evidences of scientific achievement are: Number of dockets filed, number of patents granted and in use, number of scientific papers produced on subjects of Company interest, number of technical reports issued or presented orally, and number of Company people who consult the employee. These are valuable criteria that can, in some circumstances, be used as partial measures of achievement. However, such tangible indications of output can be misleading. Consider the writing of technical reports. A clever individual may have a large output of impressive looking reports of little real value, whereas the creative worker may write a few poor reports, but proceeds directly to working embodiments of his ideas.

The less tangible results of a scientist's work include: Original ideas, new discoveries, interpretation of scientific information, and suggestions for research work or for the application of research results. Values such as these do not lend themselves to precise measurement according to a set of absolute standards, but they are a most important constituent of a scientist's total output.

In group activity, which is essential to the exploring of new scientific fields and the exploiting of new discoveries, it is very difficult to evaluate definitively and currently the individual contributions to the progress of the group. Another factor that complicates evaluation is the time delay that necessarily intervenes between research findings and their use in practical applications. Through no fault of the scientist, the results of his research may lie fallow for years before others make use of them. And, by the time a new development reaches commercial fruition, many individuals both within and without the laboratory, will have made additional contributions. Even the evaluation of a new commercial product, material or process growing out of scientific research cannot be made with any degree of accuracy until a period of years has elapsed, thereby making it difficult to assess the value of an individual's contribution.

In scientific research, nature holds the final veto—the power of success or failure. Precisely the same application of skill, energy, judgment and specialized knowledge may, in one field, yield results with important practical applications; in another, it may draw a complete blank in terms of practical use. This speculative aspect of research must be recognized in evaluating ability and output.

The opening of new technical fields complicates any comparison of research work conducted in a rich new field—which may yield an avalanche of important results—with the steady, but less spectacular contributions of workers in fields that have passed the avalanche phase. The latter type of work is of continuing importance because it usually concerns fields of vital interest to the company. Thus, it becomes management's problem to recognize progress made within a given framework of conditions that may be either favorable or unfavorable to the individual. Management also has the problem of proving to those working in older, and possibly less rewarding, fields that it can, and will, recognize progress under any set of conditions, and that the individual will not suffer by virtue of these conditions.

of the organization. They generally have professional associates who are either seeking new opportunities or who might be of assistance in providing the names of qualified candidates. The utilization of such associates usually yields an impressive list of prospects, and staff members procured by such means represent just about the best type of employment risk. Extreme caution should be taken, however, to limit the contacts to persons actually desiring a change of employment in order to avoid accusations of "pirating."

Colleges and Universities. If a company anticipates continuous requirements for research personnel, it should plan a long-term recruitment program in several colleges and universities. Practically every major college and university has a well organized program for circulating the requirements of industrial, governmental and independent organizations among interested students and for setting up interviews on the campuses.

The college program should be carefully planned. The placement director should be given copies of the company's requirements to permit effective circulation among the faculty and students. This literature should be attractive and include pertinent sales points. Itineraries of recruiters should be strictly adhered to. For the actual interviews, scientific and engineering staff members of the organization should be utilized if at all practicable, particularly for interviews with graduate students.

In addition to the student placement services, many of the major colleges and universities have formal alumni placement services. Files of alumni or friends of the college or university desiring an employment change are maintained and these are usually available for scrutiny. In certain schools, the job requirements set down by the company are circulated among the alumni. This service is highly effective and is done at no cost to the employer.

Advertisements. Newspaper advertising is an effective medium for filling a position in the shortest possible time. If this type of program is planned, it should be remembered that today's market is highly competitive. An effective selling job must be done and, hence, all major sales points should be included in the listing.

The results of a newspaper adver-

tisement program are highly unpredictable. Advertisements are highly effective for positions in fields of activity where shortages are not acute and, in addition, draw applications from scientific and engineering personnel at the earliest possible time. But, such advertisements will bring in applications from persons who are not qualified for the position listed, and a careful screening job must be planned.

If time is not important in filling a position, advertisements in scientific, engineering and trade journals are highly effective. These advertisements are read by a very select group, thereby reducing the number of applications from non-qualified personnel. No less than two or three months are required for positive results.

Placement Services. The practices of these groups vary widely, some offering an effective evaluation service and others making more or less random referrals. Some give their services at no cost to the employee, while others provide the same service at no cost to the employer. The better agencies do an effective job in supplying candidates for non-specialized positions, but very few are able to screen properly those people applying for high-level scientific and engineering positions.

Many of the larger technical societies maintain placement services for their membership. These services are usually more effective than those of the agencies. Thus, if placement services are to be used, the society services should be consulted first and the professional agencies second, and then only after determining the experience of the agencies in the scientific and engineering areas under consideration.

Separation Centers of the Armed Forces. Recently the Army organized a program for assisting discharged service men in their search for work after completing their tour of duty. The separation centers, totaling more than thirty, accept requirements from interested employers and arrange for interviews in a manner similar to the system used at universities.

Evaluation, Selection and Placement

The selection of a specific candidate to fill a given position is a critical job, mainly because it involves the first and all-important personal contacts. The evaluation must be as complete as possible, and all possible tools available for the evaluation process should be utilized.

After a study of application data, the candidates warranting additional consideration should be written and "sold" on the company. At this time, they should be invited to submit complete application forms. If a large number of requirements exists or is anticipated for the future, it is a good investment to prepare a specific application form for scientific and engineering personnel. Such a form should have spaces for detailed information on graduate study and professional activities, as well as for general information normally found on an application form.

The completed application forms should then be carefully analyzed to determine which of the candidates, if any, meet the requirements of the position. To avoid any possibility of ill will, the unacceptable candidates should be promptly notified; at the same time, the qualified candidates should be invited for interviews.

The most effective tool in the evaluation process is the interview. The impression created during this meeting is highly influential in the future decisions of the applicant, so this phase should be handled like a "top-level selling job."

During the interview program several company representatives should meet the candidate for the purpose of evaluating his technical abilities, his personal traits and his enthusiasm for and interest in the type of work provided by the available position. The representatives themselves should exhibit an enthusiasm for their company, and for the work in which they are engaged. The "sales" effort should be entirely honest and complete, and the candidate treated with courtesy, respect and dispatch.

The results of the various interviews should be accumulated, and specific points of information to be obtained from references tabulated. The references listed by the candidates should then be checked—by telephone, if possible. These people should be asked specific questions about the performance, personality and experience of the candidate rather than generalized inquiries. It is also good practice during the reference check to verify a few specific items listed by

CHARACTERISTICS OF RESEARCH WORKERS

Importance of Freedom

With rare exceptions, the research worker wants and needs a considerable amount of freedom—freedom from strict supervision, freedom to plan the details of his work, freedom from rules and regulations, freedom from interruptions, freedom to discuss his work with his colleagues and superiors, freedom to publish technical papers, and especially freedom to spend part of his time working on ideas which are completely his own and unrelated to his assigned work. He does not desire an absence of supervision or planning; he abhors the frustrating experience of not knowing what is expected of him, almost as much as he abhors regimentation.

Logic and Curiosity

By training and inclination, research workers want to know why things work. This spirit of logical inquiry is not confined to technical problems but extends to all the rules, regulations, practices and events that affect them. They may tolerate illogical control practices if they are required to do so, but they will not cooperate to make these practices effective unless they are worthwhile.

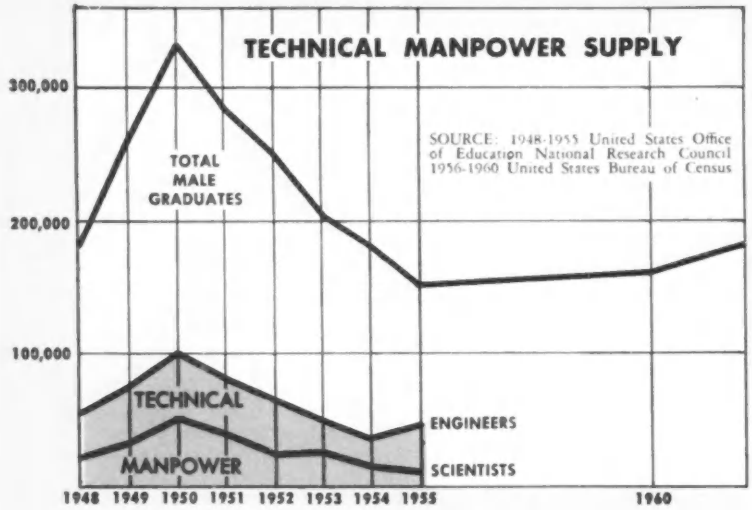
Individualism

Although it is frequently necessary that technical men work in teams and that there be close cooperation between groups working on related aspects of the same problem, the typical research worker prefers to work by himself as much as is consistent with the program of the laboratory.

Attitude Toward Administration

The research worker typically does not understand or care much about the problems that confront the management of a laboratory. In general, he believes that these problems are less important than the specific technical problems on which he is working. He expects that the material or services he needs from shops, inventory, the procurement organization, or other service departments will be furnished promptly, exactly as he specifies, and without red tape.

Division of Research, Harvard Business School



TIPS ON NEWSPAPER ADVERTISEMENTS

(1) A single advertisement in a well-known newspaper is considerably more effective than several listings in papers of smaller circulation.

(2) For scientific and engineering positions, neighborhood, foreign and denominational newspapers are not nearly as effective as papers of wider circulation. The cost of such advertisements is very small but the results are limited.

(3) A single advertisement, attractively designed and given adequate space, is much more effective than a series of classified ones costing the same amount.

(4) For high level administrative, scientific, and engineering positions an advertisement in the business pages is considerably more effective than one of the same size in the classified section.

(5) Advertisements for scientific and engineering positions using the company's name are more effective than blind advertisements.

JOB FUNCTIONS OF A RESEARCH DIRECTOR

As scientific adviser he keeps top management posted on developments likely to affect the company and furnishes an informed opinion on the probable significance of these developments as well as action that should be taken.

As chief liaison man, he obtains the funds to operate the laboratory, sees to it that research ideas and needs generated throughout the company flow into the laboratory, acts as a buffer to protect the research workers from unwarranted interference by persons outside the laboratory, and sells the products of the laboratory to top management and others in the company.

As program pilot, he makes, or participates in making decisions as to what work is to be started, stopped, expanded or contracted. Unless the laboratory is small, the research director does not actually create many research ideas; rather, his function is to appraise, or to see that someone appraises, ideas created by others in the organization and the work done to investigate these ideas.

As manager of the research organization, he has the jobs of motivating the organization, of getting its members to work together effectively toward planned objectives, and of seeing to it that resources furnished the organization are used as efficiently as possible.

Division of Research, Harvard Business School

the candidate on the application form, and also to conclude the check with a direct question of the type, "Would you like to have Mr. X on your staff again?" As many references, preferably business associates, should be checked as is feasible.

During recent years aptitude tests have been developed at a remarkable rate, and many employers utilize them in their evaluation programs. Such tests are a good investment, provided they are used as *one* tool for evaluation rather than *the* tool. (Product Engineering, May 1952).

When all information has been accumulated on the candidates for a given position, this material should be given to the company representatives who interviewed the candidates. The successful candidate is then selected. This final step should be completed as expeditiously as possible for two reasons. First, the successful candidate may be considering other positions and might accept employment elsewhere if a specific offer is not immediately forthcoming; second, ill will could be created among the unsuccessful candidates who might decline offers from other companies in hope of being selected.

A letter of appointment should then be sent to the successful candidate or candidates, highlighting important details of employment. Letters should also go to unsuccessful candidates to conclude their cases, stating that their qualifications have been considered.

Indoctrination

During the interview, the candidate should have been given a general description of the policies and practices of the company. However, at that time, he was receiving a large volume of varied information. Thus, upon reporting to work the new staff member should devote the initial day of employment to learning about company policies, practices and programs; about his specific position and assignments; and about his associates.

The personnel department should greet the new staff member with enthusiasm and make every effort to convince him that he is now an important part of his new employer's operation. Over-all policies, practices and objectives of the company should be reviewed, and any necessary paperwork dispatched quickly.

Upon reporting to his supervisor, the new man should be acquainted with the policies, practices and objectives of the department and told how he fits into the research picture. Adequate time should be taken to assure the new member that he "belongs" and to avoid the possibility of presenting an inadequate or an inaccurate picture of his new position. Here the new staff member might be presented with the written specifications of his position which, as has been stated before, outlines the scope of his duties and responsibilities. The new staff member should also be introduced to his new associates.

ARMY SEPARATION CENTERS*

Arkansas	—Army-Navy Hospital, Hot Springs	Massachusetts	—Fort Devens
	—Camp Chafee	New Mexico	—Sandia Base, Albuquerque
California	—Fort Ord	New Jersey	—Fort Dix
	—Presidio of San Francisco	New York	—Fort Jay
	—Camp Stoneman	No. Carolina	—Fort Bragg
Colorado	—Camp Carson	Oklahoma	—Fort Sill
	—Fitzsimmons Army Hospital, Denver	Pennsylvania	—Carlisle Barracks
Georgia	—Fort Benning	Texas	—Fort Bliss
	—Fort Gordon		—Fort Hood
	—Fort McPherson		—Fort Sam Houston
Illinois	—Fort Sheridan	Virginia	—Fort Belvoir
Kansas	—Fort Riley		—Fort Eustis
Kentucky	—Fort Campbell		—Fort Lee
	—Fort Knox		—Fort Meyer
Maryland	—Aberdeen Proving Ground		—Fort Monroe
	—Army Chemical Center	Washington	—Fort Lawton
	—Fort Meade		—Fort Lewis

* Proceedings on Conference on Manpower Utilization and National Security, September 7, 1952, Chicago, Illinois, pp 27-28.

Poster describes Armour co-operative plan for obtaining an engineering education

On several occasions during the new man's first week or two of employment, the supervisor should make a point of asking him whether he can provide any assistance during this period of adjustment. Further, after the supervisor has had occasion to evaluate the efforts of the newcomer, he should discuss his performance, and assist him in absorbing his responsibilities at an optimum rate.

Professional Development

Today technology is expanding at such a rapid rate that an effective personnel program has to provide staff members with the opportunity of keeping abreast of the new developments.

Advanced Training. Practically every major industrial organization supports an organized training program for its young staff members. Such a program might include assignmenrs in the various organizational components of the company or formal lectures designed to acquaint the new employee with the company, its products and the fields of technical activity necessary for the growth of the individual. In many other instances, training is accomplished through formal course work in nearby colleges and universities. In some instances, the company permits this college work on company time, and, in general, it absorbs all or part of the tuition costs.

Fundamental Research. Scientists and engineers who have actively conducted research during their academic programs usually have an intense enthusiasm for pursuing fundamental research as a means of keeping up with their fields. Aggressive companies provide mechanisms for permitting staff members with such interests to spend a limited amount of time on fundamental study. This study often results in a publishable scientific or engineering paper, which can bring much credit to the company and to the staff member.

Professional Activities. Such participation should be enthusiastically encouraged, even to the extent of paying part or all of the costs involved in sending a staff member to meetings of societies. The company should insist upon active participation. This might include presentation of papers at society meetings, handling of committee assignments, reporting on such meetings, and other tasks that might promote the growth and prestige of the company and the individual. In particular, scientific and engineering personnel should be encouraged to prepare papers for technical journals.

Supervisory Development Programs. Experience has demonstrated that engineers make excellent executives. But, the average staff member is not concerned with business and supervisory activities, so he should be encouraged to familiarize himself with the principles of business and management. At the Fifth College-Industry Conference on "Opportunities in Engineering," sponsored by the American Society for Engineering Education and Northwestern University, it was pointed out that, for future growth and development, the engineer should acquaint himself with the basic principals of: Accounting, economics, money and banking, government, organization and management, human relations, statistics and marketing. This additional training will also equip him for responsibilities in his community.

Employment Incentives. While an intelligent and aggressive professional development program provides a major incentive for scientists and engineers, an alert company never neglects other employment incentives, particularly those generally provided for all types of personnel. Such discussions can be found in any general book on personnel administration or industrial psychology.

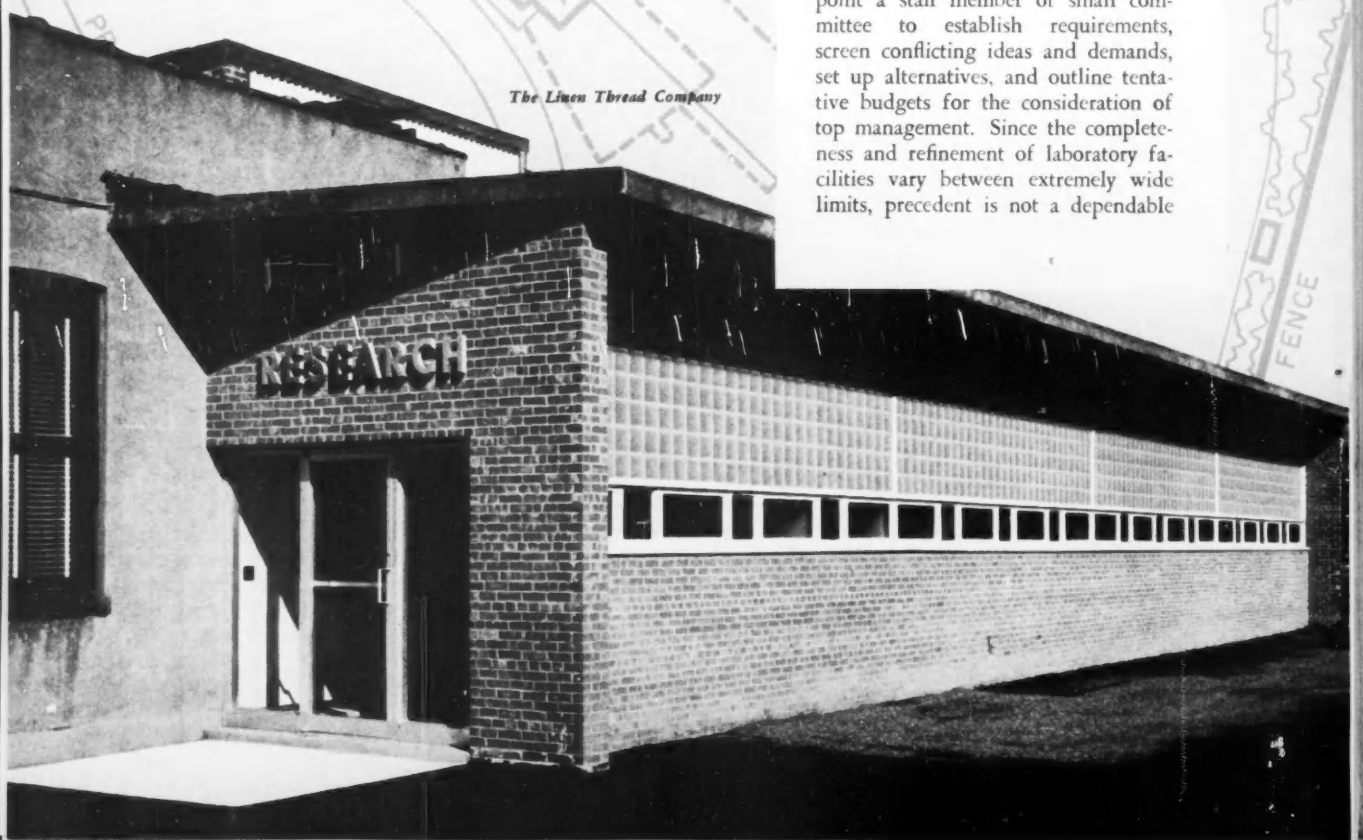
The procurement and administration of research personnel is not any easy task when the demand for such personnel so greatly exceeds the supply. Keen competition for competent talent keeps salaries—and turnover—at unprecedented high levels. But dollars alone do not keep most scientists and engineers happy and productive. Down-to-earth human relations programs can give research staff members the feeling of "belonging," enhance productiveness and reduce personnel problems, particularly those concerning excessive turnover.

Policy Matters in LABORATORY DESIGN

ROLAND A. WANK
Fellheimer & Wagner
Architects & Engineers, New York City

Research laboratories are often the most complex and expensive of the various buildings that house an industrial enterprise. Their planning is, therefore, an involved process, which poses many questions for management to answer. The size and cost of the building are determined by the importance of research to the prosperity of the company, rather than in direct proportion to the manufacturing departments. Some large companies which make old, established products, have laboratories consisting of a few rooms in one of the plant buildings. In the newer fields where scientific progress or market changes sometimes render products obsolete very rapidly, the research group is regarded as the key to the future of the enterprise. The current trend appears to be in the latter direction.

When a laboratory program is initiated, it is general practice to appoint a staff member or small committee to establish requirements, screen conflicting ideas and demands, set up alternatives, and outline tentative budgets for the consideration of top management. Since the completeness and refinement of laboratory facilities vary between extremely wide limits, precedent is not a dependable



The Linen Thread Company

guide, and the job of programming requires experienced judgment. Except in the case of brand-new industries, however, a laboratory is usually projected because the old one has been outgrown or outmoded or it is time to consolidate research activities that have grown up individually in various locations. A staff or nucleus of one is therefore at hand and can be consulted.

Where to Locate

Perhaps the first consideration in the establishment of a research facility is the matter of general location. Often the most convenient place for research is close to the production plant. Utilities and services such as central heating may already be at hand; shops, warehouse space, parking and policing already available. Production personnel can be drawn on for ideas, experience and comment; pilot plant operations can be established jointly between the research and production departments; and where manufacturing entails control of raw materials or products by laboratories, these can be consolidated with the research unit. The process control staff may contribute their practical experience to the researchers, and, in so doing, may gain in morale by association with the more stimulating work.

On the other hand, some managements are wary of joining their research personnel organizationally, or even to the extent of physical proximity with process control or production. There is the possibility that scientists will become sidetracked by being brought into everyday production problems. Where the laboratory is to serve a number of plants in different localities, there is a chance that the one nearby will get preferential treatment. And of great importance nowadays is the task of finding and holding top-notch scientific talent. Plants located on the basis of production or transportation economy are often in geographic areas or neighborhoods that hamper the recruitment of this type of personnel.

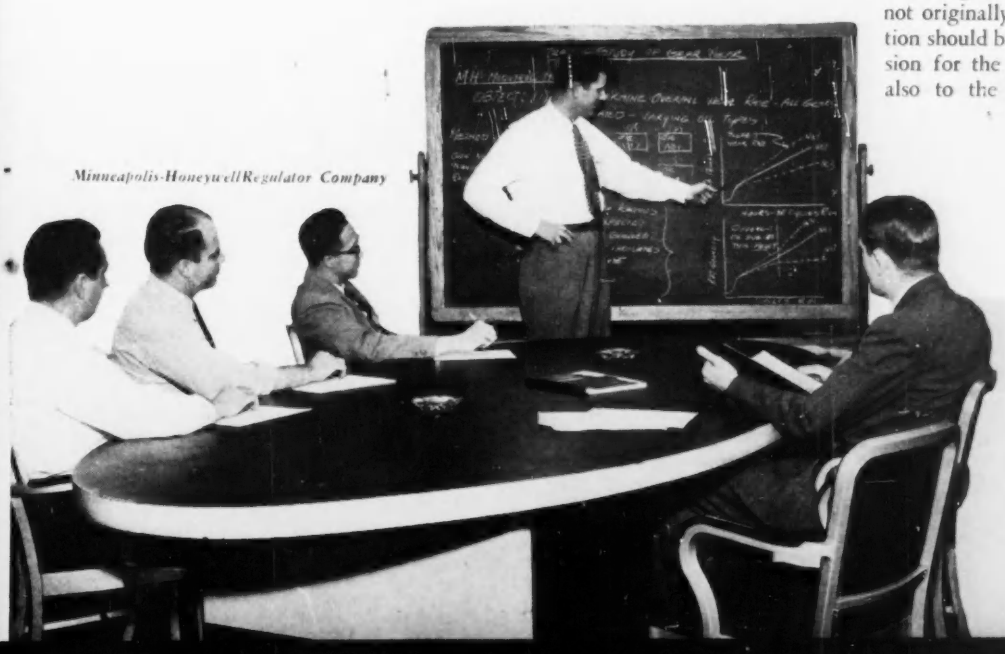
Some industries found it advantageous to house their research department close to their administrative headquarters, whether near a production plant or not. This facilitates supervision and contact with planning and marketing departments in the development of new products. If the company owns diversified plants in different locations, the services of the research department can be conveniently allocated and controlled by top management. Moreover, company headquarters are apt to be at or near a major city, which offers university and other scientific contacts to research personnel, as well as social and cultural advantages to their families. These are important factors that can be put to good use in recruitment programs.

In recent years, a tendency has developed toward still another type of location: A quiet suburban site, usually within commuting range of the city in which company headquarters are located. The atmosphere of these residential or semi-rural areas lends itself to detachment and concentration, land values are relatively low and permit a spacious layout of buildings and grounds. The charm of the working place itself and the opportunity to buy or build homes nearby on ample land are attractions appreciated by scientific personnel.

How Much Land

When the general location of a new building has been determined, a specific piece of land is selected. In that connection, the most frequent cause for later regrets is underestimation of eventual space requirements. The relative importance of research has grown phenomenally in the last few decades, and shows no signs of slackening. Even the wildest predictions of what the future may bring are apt to look timid in a few years. When a facility reaches the limits of expansion, there is not much choice: Divide activities between the old and a new location—a generally undesirable alternative—or move the whole operation at considerable cost and possibly with the grief involved in uprooting scientific personnel. The precaution that can and should be taken at the start of the project is simply to reserve or purchase more land than anyone thinks necessary. Compared to the costs of modern laboratory space, even high-priced land is relatively inexpensive.

Buildings should be laid out for all expansion that anybody is willing to predict—and then with a generous allowance for the unpredictable. In addition to the research building proper, space should be allowed for accessory uses such as pilot runs, hazardous experiments, work requiring extra large floor space, storage or shops not originally anticipated. Consideration should be given not only to expansion for the same kind of work, but also to the possibility that research



Minneapolis-Honeywell Regulator Company

As conference rooms are in frequent use, comfortable appointments, facilities for graphic display, and quietness are important design considerations.

may lead to a radical change in scope and type of work. And, as an incident to future enlargement of staff, allowance should be made for such things as parking.

Secondly, careful analysis should be made of the sewer and water supply, and the regulations and ordinances pertaining to them, for present and possible future uses. The manner in which chemical or radioactive waste (fluid or solid) will be disposed should be clearly established before a site is chosen; and possible increase in quantity as well as change in kind of waste should be kept in mind. Water supply should be analyzed in the same sense; and, whether air conditioning has any significance in the initial stage or not, availability of cooling water for this purpose should be investigated.

Thirdly, other factors of environment should be checked, depending on the type of work to be performed. Air pollution may be a handicap upon certain kinds of research. If the work involves hazards, smells or the keeping of animals, is there a question of community relations? If so, local authorities should be consulted.

Lastly, if the new project necessitates moving the existing staff to a new location, it is advisable to consult and prepare each individual before a decisive step is taken. This is especially important for older, well-established personnel who may take a dim view of uprooting their families. Considerable tact and possibly some financial recognition of the difficulties that accompany a move may be required in such cases.

Building Design

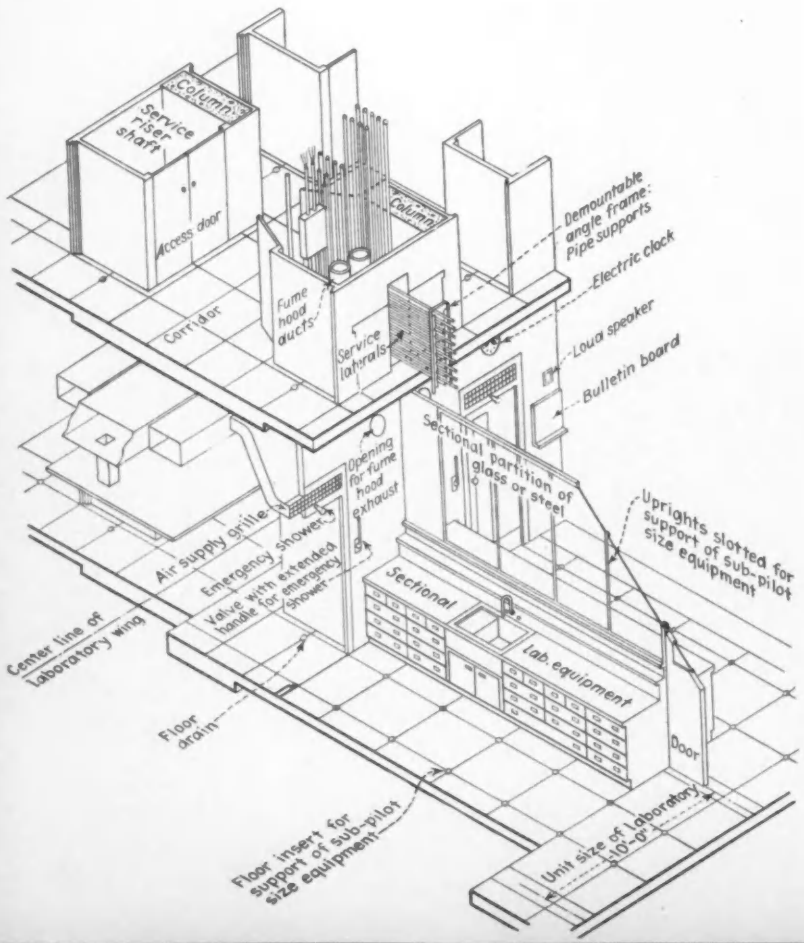
Flexibility. Many research administrators and scientists dream of buildings in which partitions can be shifted at will, fume hoods can be set up any place, electric current of diverse characteristics, gases, distilled water and other services can be supplied at a moment's notice. Architects have developed practices for making any and all of these things possible. But flexibility is costly, and it is up to top management to decide how much of it is warranted. If, for example, a large number of partitions will be shifted every year, demountable arrangements are well worth their cost. But if several years are apt to elapse before a partition is changed, the greater cost of altering permanent partitions may be outweighed by their lower initial cost.

Special vs. Convertible Space. Most industries tend to build a maximum of all-purpose laboratory space except where highly specialized work like spectrography, high pressure testing or radiography is performed. In addition, there is a marginal group of activities for which specially arranged space is desirable, but not absolutely necessary. Final decision is the result of weighing the greater convenience of special-purpose space against the probability of premature obsolescence.

General vs. Unit Laboratory. Most research buildings contain both types. The amount of space devoted to each is occasionally the subject of policy arguments as to whether ease of control over large spaces is preferable to freedom from distraction in smaller units. The preponderance of opinion may shift back and forth during the useful life of a building, so it is desirable to adopt a pattern that permits conversion of space with a minimum of fuss and cost.

Completeness of Basic Installation. This subject is related to those above. If, for example, distilled water will be required at a majority of the work tables most of the time, a costly central system may well pay for itself in a short time. But if this service were used only occasionally, a carboy brought to the place of use may suffice. Special types of electric current, compressed air, vacuum and special gases are other services that may be extended from central sources to any or all laboratories, or can be supplied when needed from portable equipment.

Completeness of Auxiliary Services. Research instruments and experimental setups are constantly being torn down, reassembled or modified as a project progresses. Shops for machining, glass blowing, welding, pipefitting and other services are provided if their utility justifies original and operating costs.



Routing diagram of services and ventilating ducts for unit system laboratory wing. Space is completely flexible with all partitions, equipment and services of removable dry construction.

Most scientists like to have these services on the premises for ready use. When costs are adjudged excessive, these services can be supplied by organizations outside the company.

Placement of Project Leaders' Offices. Individual preferences range from a desk in the laboratory for close supervision of work to a detached office for undisturbed thinking. However, there are important cost aspects worth considering. Laboratory space fully equipped with services is much more expensive than office space; where used for office purposes with a possibility of future shifts, its high cost is largely wasted. A common solution has been to locate offices close to, but independent of, laboratories.

Air Conditioning. Most laboratory buildings have administrative suites, which are apt to be air conditioned at considerable, though justifiable expense. High-salaried research engineers responsible for complex or high-priority projects are also afforded this "front office comfort."

Air conditioning of general laboratories is far more expensive because air usually cannot be recirculated. For projects currently in the planning stage, the question may well be raised whether to make provision for an elaborate duct system, which may be required in the future. Usually some scheme can be worked out whereby eventual needs are anticipated.

Daylighted vs. Windowless Laboratories. Utility riser shafts with their complex pipe, duct and conduit systems account for a substantial fraction of total building cost, so certain savings can be obtained by arranging laboratory space back-to-back, especially in multi-story buildings. With such an arrangement, corridors follow the outside of the groups, and, if this pattern is repeated, some of the laboratories would be completely shut off from daylight. Arguments in favor of this plan are: exclusion from distracting outside influences, including outdoor temperature and light changes; and economy in construction. The actual economy should be calculated for each job because provision of adequate mechanical ventilation and access to exits may cancel some of the savings.

Centralized vs. Local Control of Facilities. Many laboratory workers and project chiefs prefer to have direct control over their stock, supplies, dry ice instruments such as balances and other related equipment. On the other hand, central control of such items may reduce duplication, overstocking and mismanagement.

Library. Planning of library facilities should be based on a clearly established method for their operation. Will books and confidential reports be charged out to employees, or be available only in the reading room? If they are charged out, will they be returnable nightly or will the employee have locked space available at his working area? If books are not charged out, should there be private reading cubicles that can be locked? What material will be kept in a vault, and will microfilming be used to reduce stack and vault space?

Employee Facilities. With the prevailing tendency toward suburban or otherwise isolated locations, the lunchroom and lounging space for spending a pleasant lunch hour assume greater significance. Scientific workers like to discuss their work and theories over their meal, so it may be in the best interests of the company to promote exchange of ideas in this manner.

The question also arises as to whether top scientists and executives should be given a separate dining room. The sacrifice made under this setup is loss of personal contacts and an implied rank distinction.

Women are being given more and more jobs in the laboratory. This trend is an outgrowth of emergency measures taken during World War II and the current shortage of trained research personnel. It is therefore wise to plan toilet, locker and restroom facilities with possible reassignment or partial conversion in mind.

Public Relations. Some research institutions are inaccessible to outsiders; others encourage inspection and are used as assets in the public relations program of the company; still others have both accessible and restricted areas. Policy in this respect will affect the planning of reception, display, circulation and comfort facilities.

Lecture Room and Auditorium. Meeting rooms of sufficient size to assemble a large part of the scientific staff are often provided. If they are to be used for instruction of younger workers by senior scientists, they should be equipped with demonstration table, projection booth and public address system.

Sometimes, the meeting room is developed into a formal auditorium for receiving scientific groups, students or the general public. In such cases, controlled access from the reception lobby, coatrooms and public toilets should be made part of the plan.

Allowance for Expansion. As suggested above with respect to land purchase, extremely liberal initial provision for future floor space requirements may prolong the useful life of the laboratory many years. It is relatively easy to plan a floor layout for the addition of more wings. Difficulties crop up, however, in the proportioning of those central facilities that normally occur only once in a building, regardless of its size. Rooms for mechanical services, library, auditorium, cafeteria, etc., are typical examples.

Esthetic Considerations. When the laboratory is to be accessible to the public, that fact would have an influence upon the standards set for appearance. But even when such is not the case, the need for attracting and holding top-flight personnel dictates certain minimum requirements.

Along with general esthetics, questions arise regarding the balance between the added initial expense for high-grade materials that resist absorption, corrosion, water and dirt and the resultant future savings in maintenance, cleaning and replacement. In this connection, one of the more frequent points of contention relates to the routing of services from points of origin to the laboratory table.

Permanently-concealed piping is not much more expensive than the open type and it does solve the problem of visual confusion. But replacement or alteration become expensive and sections of the building may have to be taken out of use while floors or partitions are opened up. A number of schemes have been used for combining full accessibility to piping with its complete concealment.

The foregoing remarks are intended as the barest outline sampling of the questions that a company's planning group has to answer. They may find their task easier if the architect-engineer, to whom the project will eventually be entrusted, is at hand during the early stages of planning. Often he can throw light on alternative choices in terms of plan layout and construction cost, with sympathetic understanding of the problems faced by management and the overall cost limitations.

"The greatest durability contest in the world is getting a new idea into any factory. It is well if the management understands this and will constitute itself the sales department for the research organization. Otherwise, the hard-boiled men in the factory will put research men out of business in a fortnight. When we present a new idea to people, their first instinctive reaction is against it. Nobody likes a change. That is the one great thing you must understand in the psychology of research."

Charles F. Kettering

CHOOSING AND EVALUATING Research Projects

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Research management has been a subject of frequent discussion in recent years. One of the reasons it has gained so much attention is its paradoxical nature. What would appear to be the best and most profitable methods for managing a research department often turn out to be the ones that stifle research at its origin. Such is the case in choosing and evaluating research projects.

In tackling any problem, it is desirable to review objectives in advance and to keep them in mind throughout the whole program. The objective of industrial research has often been stated by saying that *the results of research must pay*. This has been said in many different ways and yet it is probably one of the most misunderstood and dangerous principles that can be followed. In an effort to insure profitable research output, many administrators regiment research to a point where it no longer performs its creative function. When they endeavor to make each

specific job pay for itself by setting up and predicting exactly how each project will be carried out and what the results will be, they are no longer doing research. Consequently, the more "efficient" they try to be, the less efficient the research function becomes. This is the first of the paradoxes.

In the long run, a tightly controlled research program tends only to skim the cream of scientific knowledge. The result is stagnation, both because the basic thinking behind such a program is not sound and the excessive controls are not attractive to most capable research talent. Paradoxically again, however, there are times when such controlled programs, at least for individual projects and for limited periods, are completely justified by the requirements of the industry involved. For example, research in the processing industries frequently covers many activities directed toward very specific products. This work is considered fairly predictable as to the results expected and, consequently, much better suited to complete control than is research in other industries.

The choice between control and freedom in research and the related problem of striking an optimum balance between applied research and development on the one hand and basic work on the other are among the most difficult and the most important problems in the administration of research.

Research directed along the wrong channels, or worse yet, not directed at proper objectives, can waste money more completely than almost anything else a company can do. Not only do we lose because of having spent money on projects that are not productive, but also because many important things that should be done are not done.

Along with the increased responsibility for judicious spending of the monies invested in research, there is the task of making best use of all available resources. Our dwindling national supplies of natural materials and energy must be utilized more and more efficiently. Similarly, in these days of short supply of good technically trained personnel, care must be taken to make the most of the existing and potential talents of these people by putting them to work on properly selected projects. Furthermore, time is a fleeting resource of such great value that it should not be dissipated on unwisely chosen projects.

Selection of Project Ideas

The foundation for research programs and projects lies with management. From their overall vantage point they can and should define the fields of activity in which a company will be interested.

With regard to the source of ideas, a good rule is that just about any idea should be accorded at least a look. While it is to be expected that the majority of the ideas advanced are the product of research and development people themselves, still, with some encouragement, additional ideas will come from many other sources such as customers, salesmen, field engineers, market researchers, patent experts and outside inventors. A survey of 121 industrial research laboratories included a question regarding the frequency with which research projects originated from various sources. The results showed that about 45 percent came from research and development personnel, 16 percent each from the production and sales departments, and 11 percent from executives. The remainder were from various sources inside and outside the company. All these people, in turn, get ideas from discussions with others, from literature or at scientific meetings.

It is to be expected that only a very small percentage of the ideas considered will be usable. One organization that makes a business of helping inventors has found that, in a two-year period, they looked at 50,000 ideas and found only 50 worthy of study.

Evaluating Projects

Having collected a number of usable ideas, it then becomes necessary to evaluate them. Decisions must be made as to which ideas merit investigation, which should be completely discarded, and which might have possible future significance and so should be recorded for possible later reference.

The responsibility for approval of research projects in most organizations is generally delegated by top management to the Director of Research. To do this phase of his job successfully, he should avail himself of the opinions of many others in the company, especially in connection with projects that are of the applied research or product development type. Quite often there is a research steering committee or advisory council with whom the Director of Research can consult before reaching decisions. In some organizations, this group is composed primarily of the research supervisory staff, while in others it is desired to have other key personnel present. A typical steering committee meeting has in attendance the Director of Research, his administrative assistant, and the supervisors of the subdivisions in the research organization. When issues of broad implication and sufficient importance arise, representatives of engineering, sales and/or production sit in on the discussions.

Top management, of course, has the right at any time to ask questions or request a review of research activity. Generally they have time only to review the research by fields of endeavor when budgets are approved, and assume that those doing the research know best how to get the job done. Dr. Mees of Eastman Kodak expressed this point succinctly when he said: "The best person to decide what research work shall be done is the man who is doing the research. The next best is the head of the department. After that you leave the field of best persons and meet increasingly worse groups."

In the survey mentioned above, a study was made of several preliminary phases that usually precede the establishment of a research project. The favored order in which these are taken up is: (1) Exploratory research; (2) literature survey; and (3) executive investigation, including sales survey. In many cases, these steps are telescoped to save time.

Considerations Influencing Project Selection

Probably the most important consideration influencing project selection concerns the maintenance of qualified personnel working under conditions that bring about good morale. Dr. Hutcheson, Director of Research for Westinghouse, has commented that in their laboratory, if they do not have the people for a given project, they skip the subject. This policy is greatly to be preferred to that of trying to make available people fit into squares on an idealogical organization chart. The latter practice has rarely worked well and probably is least successful in a research laboratory.

In setting up an overall research

project, the question usually arises: How much research should be basic, and how much should be applied research and development. A fundamental need for decision between basic and applied research is the fact that not only the approach to a problem, but also the techniques of its administration can vary widely, depending upon the decision of the type of research to be done.

Basic research is exploration for knowledge of such a broad nature that one cannot be sure just what product will result from it. This does not mean that efforts should not be confined to fields which will have a high probability of application to the company's products.

In applied research and product development, aims become more defined and a specific product or type of product is kept in mind. More attention is given to making sure that there is a market for the particular type of product and that the costs of research, if the results are limited to that application, will not be far greater than any profits from such devices can justify.

From factors like these is derived the general principle that the nearer research objectives are to application in products, the more controls must be applied to insure profitable, saleable products. Conversely, the more basic the research, the more freedom must be allowed, to permit originality and the incubation of new knowledge upon which other work is founded.

Several questions should be considered in connection with projects in the realm of basic research. First, is the subject basic and important to the company's business? To a company in the heat regulator business, an intensive study of the fundamentals of the combustion process, humidity or the various modes of heat transfer would be basic and of sufficient importance to justify the expenditure of considerable effort. Second, how broad an approach should be made? The scope of the work is usually regulated in terms of management's viewpoint and the amount of funds available for maintaining the necessary research facilities and personnel. And third, what is the possibility of other departments not taking sufficient interest in a subject to follow up on it? This problem can often be avoided by establishing congenial personal relationships and using good salesmanship throughout the company at all times.

In applied research and product development, the company's needs and problems are the prime considerations. These projects may grow out of basic studies or result from market analysis reports on current and projected sales demand or other market conditions. The big question here is: What portion of the company's business stands to be affected? This involves factors of marketability, cost and profit margin. The question of how much risk is involved includes consideration of the size of the project and its probable cost. Such factors pertaining to applied research and product development can be more precisely evaluated than those that concern basic research.

The availability of necessary research facilities and of people capable of doing the work also influence the choice of project. If the right people are not immediately available, can they be freed from other projects later on or should more people be hired to do the job in question?

Closely allied to the foregoing is the question: What is the probability of success? Here, a factor that might be called "ideas-for solution" (I.F.S.) enters the picture. It is more natural to pick a less important problem because a staff researcher *has* a solution than it is to embark on a more important project for which there is no immediate solution. The important project loses out because it has a low probability-of-success or I.F.S. factor.

Of course, this does not mean that a problem should be tackled only when its solution is known. On the contrary, the main purpose of research is to develop *new* ideas and only by setting up and working on a project can this be achieved. In the event there is a delay on a project because of a low I.F.S. factor, the need for ideas in this field should be made known to the Research people so that "informal" thought and work can be given to finding a solution.

Project Development

For the most part, research projects usually grow out of needs and problems pertaining to company products, and as such come under the heading of applied research. Then, as the study of problems proceeds, textbooks become inadequate and there is need for new information before intelligent decisions can be made. If these decisions are important, and especially if they crop up repeatedly in several projects, a program in basic research may be set up to supply the necessary information. By this method, a laboratory matures in the direction of more basic research.

A research program can also grow in the opposite direction—from basic to applied research. In such instances, fields in which there is need for a better knowledge of fundamentals are chosen. Typical examples are the study of combustion or semiconductors, knowledge of which will later be utilized in the development of products yet undetermined.

Regardless of which direction a research program develops, it is safe to say, the real value in research is in the more basic and longer-range problems. Efforts to make improvements in equipment using known principles are certainly important and necessary to a business, but there are countless examples in which a new angle of approach has changed market conditions so completely that a product of long standing becomes completely outmoded.

It is important, however, if an industrial laboratory does basic research, to make sure that the gap between such work and the application phases of engineering is adequately filled. If little or no effort is made in this direction, the basic knowledge obtained will go unobserved and unused, thereby defeating the purpose of the research function. Here is good reason for the Research Director to sell his "product" throughout the company.

Research and the Company

Assuming that the desired talent and necessary research facilities are available, much depends on the extent and quality of the relationship between research and the rest of the company. For most satisfactory operation, this must be a two-way communication. Research people should be constantly aware of company problems, and at the same time, they should advise interested parties within the company concerning results of their research. This association of research people with those of other departments is to be encouraged at both the supervisory and the working levels.

This interplay between research and other departments is a combination of

personnel relations and selling. It involves a helpful attitude toward other people's problems, rather than competition with these people. It means instilling during personal contacts with others a feeling of give-and-take, rather than a spirit of jealousy or excessive pride.

The selling of research to management and other people in the company is mandatory if there is to be a return on the research dollar in the form of saleable products. Generally, it is the job of the Research Director to sell the "products" of his department to management and the heads of other departments. Through all means at his disposal, he must keep others interested and aware of technical developments, expressed in terms of their business significance.

While formal reports are the prime means of transferring the products of research to interested parties outside the research organization, there are numerous other techniques. For example, at Minneapolis-Honeywell, a *Technical News Digest* has been established for disseminating to technical personnel and management the high points of current research operations. This medium of communication not only reaches many people who would not take the time to read a formal report, but it also conveys the information to them much sooner than is possible through formal reports.

Conversely, if the research department is kept well-informed on the company's needs and problems, the people in research will be better equipped to choose the most profitable projects for themselves and will direct their efforts in useful channels. A typical example, illustrates this point. If it were the opinion of the Director of Research that the company should manufacture a photoelectric relay as a regular product, how would he go about implementing this belief? Should he immediately establish a project in Research?

A photoelectric relay is a specific device, and before embarking on such a project, the matter should first be discussed with Management, Sales and Market Research to find out what potential there is for doing a profitable business on this item. In gathering the facts needed when proposing this idea, a preliminary study might be made in Research in order to have a basis for further analysis and to see what design features such a relay should include. It might be decided: (1) To make the relay using printed circuit techniques perfected in Research; (2) to utilize new photoelectric cells developed in Research; (3) to mold the chassis out of new plastics recently tested in the Plastics Research Laboratory; or (4) to incorporate some of the new gaseous amplifier tubes or transistors developed in Research.

In setting up research projects on printed circuits and transistors, the Director of Research had *not* gone through a long market analysis study. He knew there would be a use for both items and that the people in Engineering were interested in these subjects. In establishing the photocell project, the Director had in mind flame detectors, which represent a substantial volume of sales. There was no doubt as to whether such projects were worthwhile. They are basic to business.

If a study of the sales demand for a photoelectric relay yields a favorable indication and if Management decides they would like to add such a device to our line of products, a project would be set up making use of the benefits of Research enumerated above. In fact, these items might well make the difference between the competitive success or failure of the device.

Resumes of research projects, currently under study are circulated periodically among designers and management in the periodical, **Honeywell Technical News Digest.**

HONEYWELL TECHNICAL NEWS DIGEST

Volume 1, No. 1 Engineering Edition

Here is your first number of the HONEYWELL TECHNICAL NEWS DIGEST, dedicated to giving you in concise form high points in Minneapolis-Honeywell General Research. It is intended for Company management and for Honeywell Research and Engineering personnel and others who need to know and cannot find time to read all of the complete research reports.

Humidity Elements

To meet persistent demands for the measurement of humidity, many methods have been considered, such as dew point determination, volumetric methods, absorption of infrared radiations, and use of various expansive and conductive materials. A humidity sensing element, consisting of a 1-1/2 by 1-1/2 plastic base upon which two gold foil grids were embossed hasbeen developed to indicate the relative humidity by a variation in the electrical resistance of a hygroscopic film coating over the entire sensing element. The logarithm of the electrical resistance of the element is a linear function of the relative humidity over the range of relative humidities recommended. Standard humidity elements are now in production. Field test results have been generally good; the M-H humidity elements are better than their competitors, particularly on the basis of protection and stability. In recent quality control tests on some 191 elements selected at random from Finished Stock, the resulting measurements for the entire lot were found to fall well within the engineering specifications. M-H Research Report MR1526-85 presents "Technical Information for Use of the Minneapolis-Honeywell Humidity Sensing Element."

In the meantime the General Research Laboratory is continuing its investigations of other hygroscopic polymer films that might be used with the elements to ascertain the effects on operating ranges and characteristics of the elements so coated. Furthermore, a special test unit has been constructed for calibration work at low temperatures (in the order of -30 to -35°F.) and low humidity for use in determining the characteristics of the elements under those conditions.

Direct Reading Relative Humidity Indicators

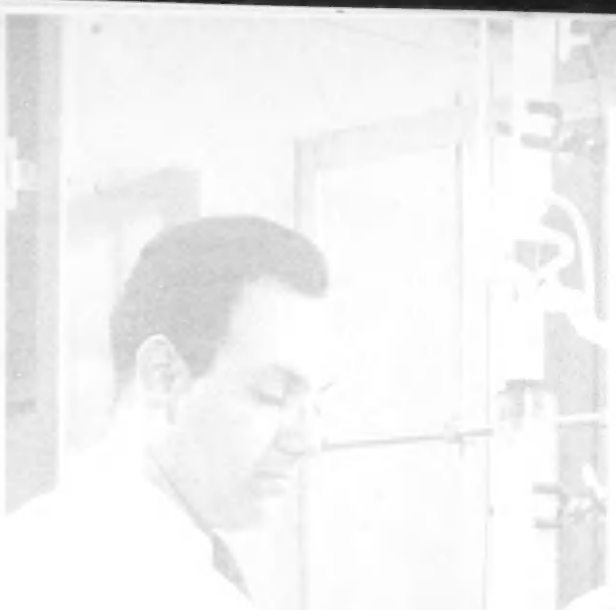
In addition to the Brown Electronik Recorders and Controller systems, the need for humidity indicators has been felt repeatedly. Such humidity indicators have been developed and models built for plug-in and battery operation. Some units have a built-in temperature compensation circuit while others do not. M-H Research Report MR1826-85 describes these indicators in detail.

This program has been given a special impetus by the requirements of the government for elements to test packages in "sothbully" storage where the safety of items such as 2100,000 airplane engines, etc. may depend on maintaining a safe humidity. Our humidity element with its special housing and amplifier unit developed by our M-H Design Department has passed tests at the Frankford Arsenal and there are prospects for large quantity sales in the offing.

Importance of Basic Research

The organizational plan of a given company does much to influence the nature of research projects; problems which work well in one type of company are completely out of line in another. In a big company there may be a large central research laboratory engaged almost entirely in basic research work for the purpose of building up a background of knowledge in the main fields of the company's business. In a smaller company, not strongly capitalized, it may be necessary to apply practically all research effort for some time to projects that are reasonably certain to pay off—in general, shorter-range and application type developments. Such a condition should be looked upon as a temporary expedient in Research.

A statement by Vannevar Bush is apropos: "Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes do not appear full-grown. They are founded on new principles and conceptions, which in turn are painstakingly developed by research in the purest realms of science. . . ."



AVERAGE COST OF RESEARCH PERSONNEL BY INDUSTRY, 1951*

Industry	Engineer or Scientist	Research Employee
Electrical machinery	$28,100	$9,400
Transportation equipment	27,700	10,000
Primary metal industries	21,600	10,100
Petroleum refining	20,900	8,100
Stone, clay and glass products	18,600	6,600
Machinery (except electrical)	18,500	8,100
Professional, scientific and controlling instruments	17,900	7,500
Fabricated metal products	16,500	8,000
Chemicals and allied products	16,500	7,900
Other manufacturing	16,300	8,400

** Bureau of Labor Statistics and Research and Development Board: "Industrial Research and Development, A Preliminary Report," January 1953*

Setting Up RESEARCH

The process of budgeting for a research program is considerably different from that of budgeting for a manufacturing operation. The difference arises from the fact that in the factory, management can expect that an expenditure of X dollars will result in an output of approximately Y units of saleable product. In a research laboratory, except when projects are well into the development stage, no one can predict with any degree of confidence the relationship between dollars spent and results achieved.

Having recognized this difference, some persons conclude that any attempt to make a research budget is futile. The fact is, however, that most industrial companies with a research organization of any size do prepare a research budget, and many report that it is a necessary and useful management tool.

Although there is considerable variation in detail, most companies which successfully use a research budget follow a common pattern in formulating such a budget. This pattern consists of: (1) Setting a target figure and deciding, in general terms, the size and direction of the research program; (2) preparing detailed budget estimates within the scope of this general decision; (3) reviewing and coordinating the program within the research organization; and (4) obtaining top-management review and approval.

Setting the Target Figure

Company managements would like to know of a rule or formula for determining how much to spend for research in its various forms. It is easy to formulate a theoretical rule: "Spend enough so that the results of the research program will keep the company growing at a desired rate." Unfortunately, there is no practical way of deciding exactly what this amount is. There are some very rough guides used in a number of companies, of which the most common is the percentage of sales that competitors spend on research. Other ratios are in use, but more important is the ability of the research director to sell top management on the benefits of research in general and on the value of the program to be mapped out for next year in particular.

In the early stages of planning and discussing the budget, no attempt is made to prepare or defend a detailed program. General discussions might include rough estimates of: (a) The probable spending necessary to keep

Sylvania Electric Products, Incorporated

RESEARCH BUDGET PLANNING FORM

Department _____ Budget Year _____

Item	1953 Budget Estimate	Planning Date: Actual, 1952 to Date	1952 Budget	1951 Actual	1950 Actual
Salaries, technical					
Salaries, other					
Wages					
Employee benefits					
Research materials					
Telephone and telegraph					
Books and periodicals					
Repairs and maintenance					
Charges from other Depts.					
Miscellaneous expenses					
Controllable overhead					
Total					
Less charges to other Departments					
Net Expense					

BUDGET QUIZ FOR RESEARCH ADMINISTRATORS

(1) Prior to the time for preparing the budget, is the approximate size of program the company will support known? Are other key personnel in the research group given this information?

(2) Is top management kept well informed of research plans as they develop?

(3) Is it general policy for research supervisors to prepare their own budgets?

(4) Are budget forms kept short and simple?

(5) Are budget estimates reviewed on a personal basis with the supervisor who prepares them?

(6) After being approved, is budget information disseminated among key research personnel?

(7) Is the budget used as a device for checking whether the program is properly balanced?

(8) Is it general knowledge in the research group that the budget can and should be revised *if* a new development or change in plans warrants?

BUDGETS

R. N. ANTHONY
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the company's product structure technologically abreast of or ahead of competitors' products, (b) amounts required to complete important development projects currently underway, (c) planned spending on important new research projects, and (d) the amount that should be risked on efforts to find new products or processes, or to do fundamental research. These estimates are often broken down according to the company's operating divisions or main product lines.

In many companies, not even these rough estimates are used, and preliminary discussions are entirely in terms of whether the *total* amount to be spent on research should be more than, the same as, or (in a few cases) less than the amount spent in the preceding year. This decision hinges on such factors as probable sales, availability of capital to finance both the research project and the plant investment required to make a new product, and rumors as to new or improved competitor products. Since many of these factors are nebulous and difficult to appraise, and because the relationship between money invested in research and results obtained is so uncertain, much depends in the last analysis on management's confidence in the ability of the research director and his organization.

On the basis of these preliminary discussions, top management and the research director reach an understanding as to the approximate total size of the research budget. This understanding is not necessarily stated in a formal memorandum; often it is entirely verbal. It may represent only a "feel" for management's attitude which the research director has sensed on the basis of preliminary talks. This is an important factor for the detailed figures that are put together and reviewed during later stages in the budget process are no better than the underlying assumptions regarding the overall size of the program.

It is also important that supervisors in the research organization who prepare the detailed figures know this target figure and approximately what portion applies to their particular projects. Some companies overlook this step and tell the individual supervisors to "budget for whatever you need." Since any alert research supervisor knows many ways of spending almost any amount of money, budgets prepared under such a policy are likely to total far more than the most persuasive research director could pry loose from management.

In addition to the target figure, supervisors should also be told of any major changes in the research program for the coming year, as well as modifications in company policies, objectives or practices. A contemplated change in wage rates or initiation of retirement plan illustrates the latter point.

Putting the Figures Down on Paper

Budgets should be prepared by those who are to be held responsible for carrying them out—the department head, project leader or other first-line supervisor in the research organization. If budget estimates are prepared by a staff unit, such as the accounting department, or by the research director and someone on his immediate staff, it is reasonable to expect that the first-line supervisor will not pay full attention to them. He will be reluctant to accept them as valid estimates of *his* plans for the coming year, and he may not support them enthusiastically. The budget should be an expression of operating plans, and the person best qualified to state such plans is the supervisor who is close to the scene of operation.

This practice does not require that the supervisor do all budgetary paperwork by himself; staff assistants can

provide him with the detailed calculations. Nor does it mean that the supervisor is permitted to put down any figures that occur to him; he is expected to conform to the general program developed in the first step outlined above. It does mean, however, that the important decisions and premises underlying the dollar figures of the budget are made by, or at least accepted in advance by, the supervisor of the unit for which the budget is prepared.

Estimates made by the supervisor are of two types. One is a budget by *organization* units (departments, sections, etc.), with estimated costs for each organization unit broken down into the principal elements of expense. The other is a budget by *work units* showing the estimated amount of spending on each program or major project. Many companies prepare budgets in terms of *both* organization and work units.

The format of a typical budget planning form for an organization unit is shown on page 189. The department head fills in his estimate of the probable spending for each item listed. When necessary, he can refer to various sources of background information when making these estimates. Typical of such data are accounting records showing the amount spent for each expense item during the current year to date and for one or more past years. He also may use information on the salary paid each man in the department, the projected rates for pension and insurance plans and other "fringe" benefits that are part of the departmental labor charge.

A department head can easily rework this information into a budget by multiplying the figures for the current year by whatever percentage he feels is realistic and acceptable for the coming year. This is budgeting only in the most superficial sense of the term. A *good* budget reflects what the supervisor plans to do in the year ahead, and to prepare it, he must have thoroughly analyzed his plans before trying to state them in figures.

Many companies include an item for overhead expense on the budget form. This is one figure the department head can consider lightly because there is little, if anything, he can do to influence overhead costs. Sometimes, he does not even fill in this figure, leaving it blank for later completion by the accounting department. The reason for listing the item at all is to acquaint the department head with the cost of services furnished his department by other groups in the company, and with the expense necessary to the overall operation of his department.

The work-unit budget is necessarily a rough estimate because the relative emphasis given to the various research projects is almost certain to change during the budget year. Nevertheless, the process of periodically taking stock of where you are, where you should be going and what is required to get there is obviously essential in any research organization which is more than a collection of individuals working on problems that happen to interest them. This process involves a great deal of discussion among people at all levels in the laboratory, as well as between the laboratory and other parts of the company.

The job of translating decisions based on discussions and rough estimates of budget items into a set of dollar estimates is not difficult. The relative emphasis to be given each project is usually expressed as a certain number of man-years of effort. For projects currently in process, this is likely to involve merely an estimate of approximately how much more or how much less time will be spent next year, compared with the time now being devoted to the project. For projects not yet started, a rough estimate of the time to be spent during the coming year is made. This can be based on parameters such as the time required for similar projects in the past or the importance of new projects in relation to the carry-over projects.

The time estimates are translated into dollars by applying a figure that represents the average cost per man-month or per man-year. This dollar figure, which includes salaries, all normal elements of cost and an additional amount for any unusual material needs, constitutes the budget for the project.

Internal Review of Estimates

Individual budgets for the several departments and projects are assembled in the office of the laboratory director into a composite budget which is subjected to intensive review. The main purposes of this review are: (1) To assure the propriety of the individual items and (2) to make sure that the various projects complement each other in a coherent balanced program.

To satisfy himself that the items in the individual budgets are reasonable, the research director usually discusses each with the supervisor responsible for preparing it. He may ask for an explanation of any item that appears out of line with the corresponding amount spent in the current year, with related amounts budgeted in other departments, or with other necessarily nebulous guides he uses to establish what constitutes "proper" spending. A guide frequently used is the overall cost per engineer or cost per research employee.

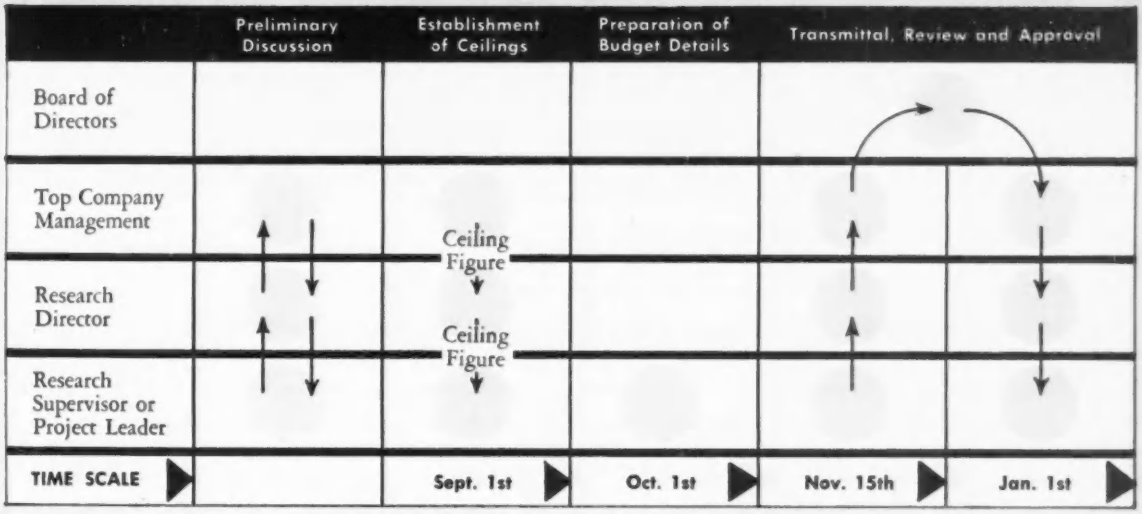
The job of checking the individual estimates to make sure that together they constitute the best overall program is a difficult one. Part of this job is done before any budget figures are put down on paper, as a part of the process described in the preceding sections. However, a much more careful examination of the program can be made by studying the actual figures.

To assist in making such an analysis, some member of the director's staff—his assistant, the laboratory accountant or the business manager—may make various recommendations and summaries of the individual department and project budgets. Typical of these summaries and their uses are:

(a) *A comparison of the total departmental budget with the total budget of the projects on which the department plans to work.* These two figures are different ways of slicing the same pie. They should agree or at least have an explainable difference representing time allowed for projects not yet planned. If, as sometimes happens, the project budget indicates that the department head plans to do more work than can possibly be done with the manpower and facilities available to him, some revision is in order. The size of the department must be increased or the number and size of projects reduced.

(b) *A grouping of individual research projects into related areas of investigation or product lines, with the projects in each area arranged according to magnitude, completion date or importance to the company.* Such a grouping makes it possible to study the *balance* of the research program: Is the correct amount of effort being devoted to the principal areas in which the company is interested? Is the number of projects likely to pay off in the

FLOW DIAGRAM FOR STEPS IN PREPARATION OF RESEARCH BUDGET



near future in correct balance with the number likely to be profitable in a longer period of time? Is some important area being neglected?

(c) *For projects worked on by more than one department, an analysis showing how the plans for each of the departments fit into one another.* This analysis is especially useful in laboratories organized so that a single project passes from a research department to a development department, and then to an engineering department. Study may reveal that one department plans to complete its work on a project either sooner or later than the next department plans to receive the project. In either case, some adjustment is necessary.

(d) *A list of the amounts budgeted by each department for each expense item.* Such a listing makes it possible to compare the amounts budgeted by the several departments for common items such as supplies and telephone service. Any disproportionate figures can be easily spotted.

(e) *A comparison of the amount of service and shop work included in the research departments budgets with similar budgets prepared by the several service departments and shops.* This comparison may reveal a disparity between the workload the departments plan to place on the service departments and the capacity of these departments to do the work.

Any estimate of a research program is rough at best, and will almost certainly differ substantially from what actually occurs during the budget year. Nevertheless, carefully prepared budgets are the organizations' best estimate of what it plans to do. If these plans are inconsistent, if the various parts do not mesh or if the program appears lopsided in some area, positive action needs to be taken to work out details.

Sometimes studies of this kind turn up facts which, from hindsight, appear obvious, but which can easily be overlooked in the course of the many and diverse items handled by the research director. Here are two examples: (1) A laboratory director desiring to use a new synthetic material in several of the company's products discovers that, although there are several separate projects planned for this work, they add up to only a small fraction of the effort he thinks is warranted in the area; each department head thought that someone else was doing the major part of the job and, as a result, no one did it. (2) An electronics laboratory finds that the shop work planned by the research departments adds up to about double the capacity of the laboratory machine shop; steps are taken to increase the work force and area of the shop, and to line up subcontractors to handle part of the load.

Review and Approval by Top Management

The final step in handling a research budget is getting it approved. If top management has confidence in both the administrative and the technical ability of the research director, if the research director has kept top management advised of the program and, above all, if the budget is based on a realistic appraisal of the amount of money top management will make available for research, this approval should not be difficult to obtain.

Management's attitude toward the new budget will be influenced by the reputation of the research organization with respect to budgets. The director with a record of realistic carefully thought-through plans and a reputation for making a consistent effort to live within an established budget will have much less trouble with top management.

Nearly all companies require some formal approval of the budget by top management and/or the Board of Directors. Before being approved, the research budget may be examined by the budget committee, by a committee representing the principal product divisions, or by a special committee of the Board. The review made by these committees is necessarily broad and is focused on such questions as the overall balance of the program, or the financial implications of new products coming out of the laboratory.

Occasionally, a question may be raised about some small point, such as the amount budgeted for books and periodicals. Generally, the sole purpose for such a question is to keep the laboratory director on his toes and ready to explain any figure in the budget.

PATENT LICENSING

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The industrial research and development laboratories in this country are responsible for many inventions that not only benefit themselves but also other individuals and groups. Of the 40,000 or more patents issued each year by the U. S. Patent Office, about half are granted to individuals, a third to small business and the remainder to large firms.

The benefits that go along with patents are made available to others through the medium of licensing agreements. These extend the rights of the inventor to others to produce or use the patented item, thereby enlarging the source of income to the patentee or assignee.

The discussions that follow are based on Supreme Court cases that have during a period of years established patent licensing practice and procedures. Each study illustrates some aspect of what the parties to a licensing agreement can or cannot do and serves as a guide for setting up the agreement itself in concert with a qualified patent lawyer.

1. *A License Can Be Written, Oral or Merely Implied.* A patent license is a waiver of the exclusive monopoly granted to the patentee by the government and amounts to an agreement by which the patentee promises not to sue the licensee for infringement. Though lawyers prefer to avoid complications by having license agreements signed and notarized to facilitate later proof, it is not legally necessary to have a formal document. A single letter is enough to establish a license.[1] The principal exceptions involve Indiana, Wisconsin and a few other states.

Many times, with nothing in writing, a license has been found to be established by oral words. In other cases, there have been no words at all, but a license implied by law from the conduct or relationship of the parties. A shop-right free license was implied where an employee made an invention on the employer's premises. Employer was licensed.[2]

2. *Patentee Can Dictate Time of License Termination.* Patentee sued a third party for infringement of patents covering a cotton baling tie that consisted of a metal strap and buckle on which was stamped: "Licensed for use once only." Purchasers of tied bales snipped the straps, and sold straps and buckles as scrap iron which third party bought, mended and sold. Having bought licensed goods, third party contended he must be licensed, but the court held that by its terms, the license had terminated and did not extend to a third party.[3]

3. *Patentee Can Withhold License When Selling Parts of Patented Whole.* The Supreme Court has held that sale by a patent owner of parts used in a patented process does not imply a license to use the process.[4] Some feel that the court later wavered from this rule.[5] However, later cases involving anti-trust and price control aspects seem distinguishable. Modern authority still supports the widely held view: If a seller of an article expressly states that no license is to be implied under any combination, process or circuit patents seller might have, there is no license under such patents.

4. *Licensee Can Imply License to Use if He Buys a Patented Article.* Patent rights were assigned to two persons, one to have all rights in

BASES FOR ESTABLISHING ROYALTIES

(1) Upon percent of what? Upon the selling price of a whole assembly or only the cost of a new component in that assembly. The scope of the patent claims may be of some help, yet often a single patent has some claims to a combination and other claims to a sub-combination of that combination.

(2) Upon apparent importance of the patent.

(3) Upon likelihood of being able to invalidate the patent if the suit is ever brought on it.

(4) Upon cost to patentee of the original development and patent activity.

(5) Upon what patentee has done in the past relative to licensing under the patent.

(6) Upon what patentee expects to do in the future: Whether he likes the prospect of competition from licensee; or, if patentee is not a manufacturer, whether he could do better by withholding a license from licensee so as to be in a position to grant a truly exclusive license to someone else.

(7) Upon licensee's plans for the future: What will be his total volume of use? Cost to patentee of negotiating and drafting a patent license, and of subsequently administering the accounts might well justify a high-percentage royalty if licensee uses the patent meagerly, a lower royalty if his use is enormous.

(8) Upon the profit that licensee can expect. The actual market value of rights under a patent covering any invention should be based on tangibles such as a small portion of the difference between profit from the proposed line and profit from an alternative unpatented line.

Policy and Procedures

the eastern states, and the other in the state of Michigan. At his place of business in Bay City, the Michigan assignee sold and shipped patented articles to Hartford in the eastern state of Connecticut. When eastern assignee sued for infringement, the court held for Michigan assignee, saying that the sale consummated in Michigan carried with it the right to use the patented article everywhere.[6]

5. *Licensee Cannot Imply That Which Patentee Expressly Denied.* No license to use in a certain way can be implied from the purchase of goods if terms of purchase state in writing there is no such license.

Notices were attached to vacuum tube amplifiers stating they were licensed for home use only. Defendant, who bought and used them for sound amplification in theaters, was held liable for infringement.[7]

6. *Patentee Can Prevent Licensee from Making Unpatented Competing Articles.* In a contract involving harrows, a licensee agreed not to manufacture or sell any other harrows than those it made under the patent license. This was held enforcible.[8]

If the contracting parties feel customers might become confused by two similar products, they can include in the license agreement the following provision:

"Each party agrees that it will use reasonable care to distinguish the appearance of articles made under the licensed patent from similar articles made or sold by other party."

7. *Anyone Can Refuse to Sell to Price Cutters.* Whether or not patents are involved, an individual can choose those with whom he will do business, and refuse to sell to price cutters.[9] However, a manufacturer cannot enter into restrictive covenants with all dealers throughout the United States, whereby all promise to resell only at certain minimum prices,[10] unless the practice is permissible under 1937 Federal enabling legislation (the Miller-Tydings Amendment to the Sherman Act) and state "Fair Trade" laws.

8. *Patentee Can Limit Price at Which Licensee Sells Articles Made Under License.* For reasons given under Section 9 below, the modern trend is away from specifying price control in patent license agreements. Yet, while some cases label such control as unreasonable per se, no cases have said it is illegal per se, and some cases have held that it is legal for a patent owner to include, in a license, terms setting prices at which licensee may sell.

In the Harrow Case cited above, the court indicated that the anti-trust laws, (Sherman Act forbidding restraint of trade, and Clayton Act forbidding acts which lessen competition or tend to create a monopoly) do not refer to the kind of a restraint or monopoly legalized by the patent laws. Therefore, patentee can impose restrictions on the price at which licensee sells articles made under the license.

In the Electric Case,[11] the government brought an anti-trust action against General Electric and Westinghouse which had contracts containing price control provisions with 21,000 lamp-selling agents. The court held for defendants that a patent owner can lawfully impose price control within the scope of the patent. Apparently the case hinged on the finding of agency, but of course anyone can impose price control upon his employees or agents. Still this case, as

well as the Harrow Case, is often cited in support of the proposition that, while a patentee cannot enforce price control against an ultimate purchaser, he can against a licensee.

9. *Patentee Cannot Control Resale Price.* In the Book Case,[12] plaintiff owned a copyright on a book in which was inserted a notice stating that any sale for less than a dollar would be treated as an infringement. Defendant, a retailer, obtained books from a wholesaler and resold them for less than a dollar. Plaintiff could not hold defendant for infringement.

In the Victor Case,[13] patentee had licenses with distributors and many dealers, but not with defendant, a retailer. License notices posted inside all licensor's patented phonograph cabinets said machine was licensed only for use with records and needles manufactured by Victor, that it was licensed only for certain minimum "royalty," and that acceptance of the machine amounted to acceptance of the license. The court declared it would disregard patentee's careful avoidance of the word "sale," because his interest in the machine was exhausted. He could not enforce price control or other terms of the alleged license against one with whom he had no contract.

In the Ethyl Gas Case,[14] where contracts stated licensees could sell only to other licensees, and set prices at which licensees' buyers could resell, the court again determined the case against the contract saying that resale prices cannot be controlled.

In the Univis Case cited above, patentee sold lens blanks which, according to the court, embodied essential features of the patented invention. The blanks were sold to licensed dealers whose subsequent grinding and polishing involved the patented procedure. The licensing agreements had price control provisions and the government sued for anti-trust law violation. Court held the government was entitled to an injunction to suppress license contracts and maintenance of the licensing system.

Thus, price control is undesirable because it opens the way for an anti-trust suit. When it is imposed in a license, price control can be taken in combination with other factors to show domination of an industry subjecting patentee, licensee or both, to civil or criminal liability under the anti-trust laws.

In the Line Material Case,[15] patents related to drop-out fuse cutouts. One defendant had a broad patent that was commercially useless because of an improvement patent held by another defendant. These parties cross-licensed each other and one of them sub-licensed ten other defendants so that the entire industry was included. All the agreements contained a price control provision, which the court used as an entering wedge to say that the entire effort was a conspiracy to dominate the industry.

A second reason for avoiding price control is that it opens the way to attack on the validity of a patent. In general, a licensee cannot question the validity of a patent under which he has a license, the theory being that patentee's claim against him is based on an alleged breach of contract and not upon infringement. However, where there are anti-trust implications, as indicated by a price fixing provision, an exception is made and licensee may contest validity. Thus, where patentee sued for royalties and for an injunction to make licensee respect a price fixing clause, the court allowed licensee to maintain his assertion that the patent was invalid.[16]

In the Gypsum Case,[17] the court held that, where there is price fixing, the government in an anti-trust suit has the same opportunity as licensee to show that the patent is invalid. Thus the government may prove that the asserted shield of patentability, as an excuse for acts which without patents would be illegal, does not in fact exist.

10. *Patentee Can Make Any Limitation Not Exceeding Lawful Patent Monopoly.* Patentee cannot, "by attaching a condition to his license . . ., enlarge his monopoly and thus acquire some other which the statutes and the patent together did not give".[14]

11. *Patentee Cannot Violate Anti-Trust Laws.* Parties to licensing agreements manufactured more than 85 percent of the country's porcelainized bathtubs. Court held the rights secured by patent do not permit making contracts in restraint of trade in violation of anti-trust laws.[18] The mere grant of a patent gives no right to ignore statutes in the public interest.

It is always difficult to say, in advance, just what might constitute a violation of the anti-trust laws. The courts have applied the so-called "Rule of Reason": Was the thing done reasonable under the circumstances? The circumstances include percent of industry involved, whether price control were present, etc.

12. *Companies Having Patents May Be "Vertically" Amalgamated.* Three companies, one having patents and making shoe lasting machines, a second having patents and making shoe welt sewing machines, and a third having patents and making shoe heeling machines, were combined by defendant individuals into the United Shoe Machinery Co. In a subsequent anti-trust action, the court said that, since patents were involved, there was a legallized monopoly.[19]

Still, an amalgamation or even a mere licensing agreement is not legal if there is restraint of trade. Copyright-owning, producing and distributing defendants consisting of several motion picture companies some of whom owned theatres, licensed other exhibitors and themselves. In anti-trust action, the court held that *combining* to fix prices to be charged by licensee exhibitors was illegal. It also required theatre-owning defendants to divest themselves of those theatres that competed with similar outlets of licensees because the "best pictures seemed to gravitate to defendants' theatres."[20]

13. *Companies Can Pool Their Patents.* As in the Line Material Case of 1948,[15] through ownership of patents, one party may have the right to prevent others from making a device, while another party has the right to prevent anyone from making the device in an improved form. Actually, neither party can make the improved device without obtaining a license under, or infringing, the patent of the other. Under such circumstances the patent owners might be expected to "pool" their interests.

Sometimes "pooled" patents are placed in the hands of an association

of manufacturers that administers the licenses and collects royalties. Widespread patent pools of this type exist legally in some fields.

In the Cracking Case,[21] government lawyers contended that the pooling of royalties precluded competition between licensors in granting licenses or sub-licenses under numerous patents relating to gasoline cracking processes. The court, noting that only 26 percent of the industry was involved, said that even if the numerous cross licenses did create a patent pool, it found nothing illegal in the arrangement.

14. *Patent Pool Should Be Open If Participants Dominate Industry.* Defendant corporations were leaders in glass making machine industry and pooled patents with restrictive licenses stating that one company should make all glass jars, another licensee should make all milk bottles. Ninety-five percent of the industry was affected. Government attorneys requested the court to order compulsory free licensing. The court refused, saying such an arrangement would amount to taking patent property without compensation. The decision did state, however, that defendants must license any comers, at a reasonable royalty, to do any or all of the things to which the individual patents were directed.[22]

Patent pools serve to circumvent patent litigation among participants, and are sometimes beneficial in promoting the rapid evolution of the most advanced products. Nevertheless, the cases already cited indicate that any such pool should not carry any anti-trust stigma, attempt to regiment production or sales, or promote control of prices at which goods made under the pooled patents may be sold.

15. *Patentee Cannot "Extend" a License To Stimulate Sale of Parts.* Though an early case,[23] is contrary, a license is illegal if it has a clause ticing to the use of a patented device the use of other devices or materials that lie outside the field of licensed patent. Thus, where patentee sold projectors with attached notices that they were licensed only for use with patentee's film (covered by different patents), the court said it would expressly overrule the Henry vs. Dick decision and hold the provision invalid.[24]

Patentee licensed a method patent in an effort to entitle manufacturers to its use only if they bought materials furnished by patentee. Defendant, a competitor who supplied manufacturers with like materials, induced them to use the patented method. Patentee sued for contributory infringement and the court held he could not recover.[25]

This case might be decided differently today in the light of the new Patent Statute which became effective the first of this year (*Product Engineering*, April, 1953).

The time has not arrived when court decisions based on this new law can be studied, but past cases can be reexamined. Perhaps, in the Motion Picture Patents Case, cited above, the film was not part of the combination claimed in the projector patent; and in the United Shoe Case the other machines were not components of the patent covering the licensed machine; yet in the Chemical Case the articles in question were a part of the patented whole. The new statute says that a patent owner shall not be denied relief against infringement or contributory infringement just because he only makes mere parts rather than the patented whole, at least if the parts are not staple articles of commerce. In view of this the Chemical Case might be decided differently today. It all depends on facts which, not seeming pertinent at the time, were not brought out in the opinion. But cases such as the Motion Picture Patents Case and the United Shoe Case would be decided the same, were they to come up anew today.

In connection with old-versus-new interpretations, the following case is pertinent. Defendant manufactured a combustion stoker switch that had no other use than in a patented combination of motor-driven stoker, room thermostat and combustion stoker switch. Patentee had previously established an exclusive licensing agreement. Licensee and defendant were competing switch manufacturers and none of the three parties made or installed the complete combination. Patentee sued defendant for infringement. The court reviewed many of the previous cases and, with four judges dissenting, concluded that patentee could not recover.[26]

In enacting the pertinent part of the new Patent Act, it was clearly the intent of Congress to overrule the precept of this case, to re-establish the old law of contributory infringement. Thus today there may be a recovery against a contributory infringer who knowingly supplies non-staple materials (not suitable for substantial non-infringing use) and actively induces infringement of a patent. This may be of importance to the manufacturer who is desirous of not suing direct infringers because they are too scattered, or are actual or prospective customers. He can now, in the proper case, assert his patent right against a part-producing competitor.

16. *Part Owner Can Grant a License.* Where two patentees *A* and *B* jointly own a patent, either can by himself grant a license. If *A* contracts with a licensee, *B* cannot sue licensee for infringement; the licensee is liable for royalties only to *A*.

17. *Patentee Can License Before Patent Is Issued.* A license can be granted even though there is no patent or patent application. However, there must be an invention, and the law requires that, if the invention is not in a patent or patent application, it must be actually reduced to practice in the form of a working model that is operative under field conditions.

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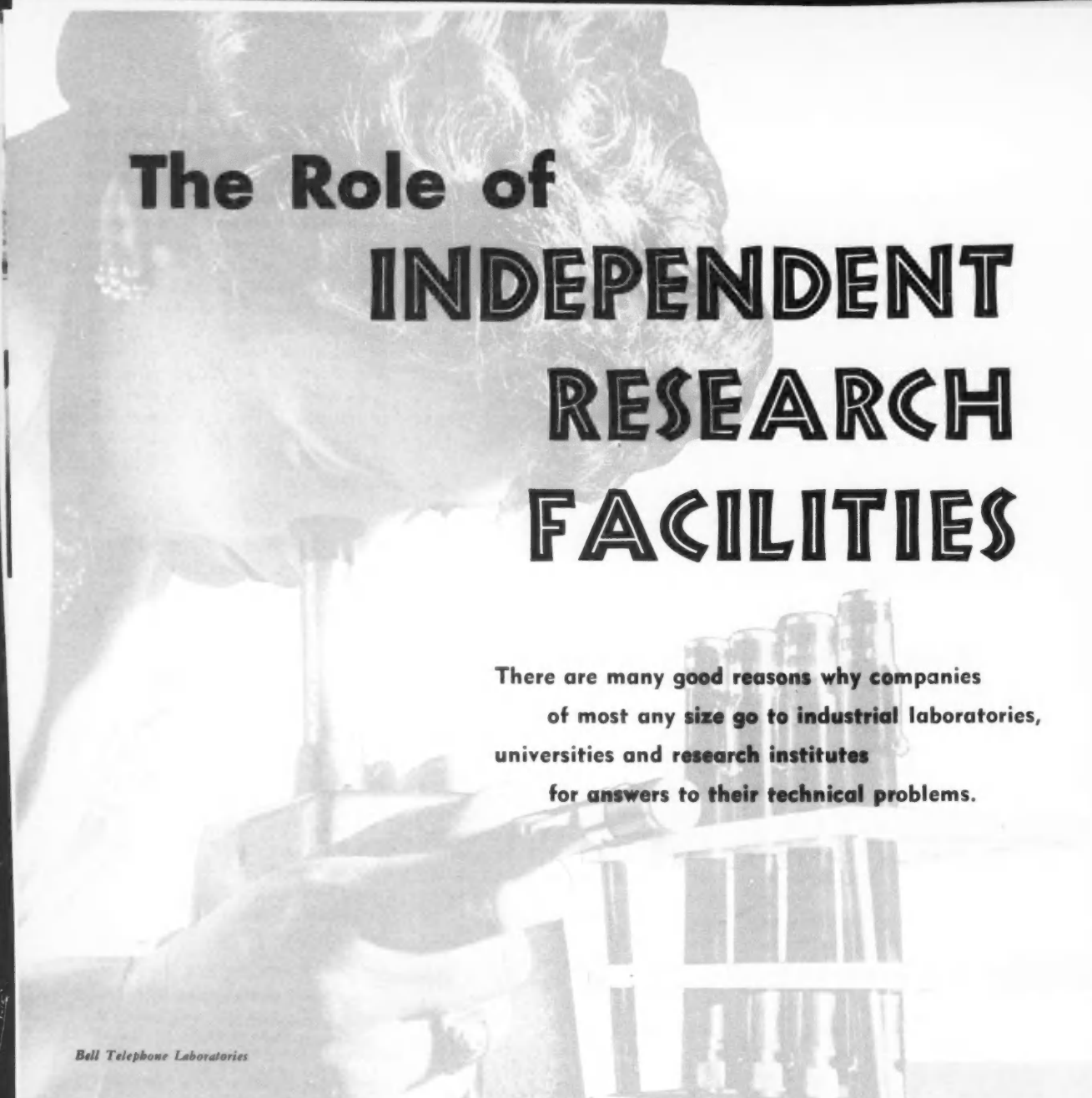
* *Key to identification: 273 U.S. 236 stands for Volume 273, U.S. Supreme Court Reports, page 236.*

The Role of INDEPENDENT RESEARCH FACILITIES

There are many good reasons why companies of most any size go to industrial laboratories, universities and research institutes for answers to their technical problems.



Bell Telephone Laboratories

IN recent years, and particularly since World War II, the practice of farming out research has become more widespread. Industrial firms now contract with outside laboratories to handle their research problems in the same way they deal with suppliers for parts used in their products.

In pointing out the reasons for the constant increase in the use of independent reasearch laboratories, this article defines the role played by contract research in corporate operations, discusses the facilities available for conducting such research, and shows how these facilities are used for solving technical problems and promoting business objectives.

There is no generic term for defining all the organizations that do contract research. For convenience, the terms "outside" and "independent" are used when referring to research organizations not affiliated with the firms engaging their services. More specifically, these organizations fall into four classifications: (1) Commercial laboratories and consulting firms, (2) industrial laboratories that conduct research for outside companies as well as for their own company, (3) universities and their research affiliates, and (4) research institutes and foundations. There are similarities and differences between these basic types as determined by their methods and fields of operation, as well as their subsidiary functions. All have the common purpose of supplying to the firm that engages their services information that will promote the firm's technical progress. Universities and colleges, of

course, have the added educational function, while research institutes have still other subsidiary purposes, such as promotion of industrial development in the surrounding region or training research personnel for industry.

Commercial Laboratories

Consulting firms and commercial laboratories handle much of the contract research placed by industry. The consulting firm may be a one-man operation, or consist of a group of men who advise and conduct investigations in specialized fields. The industrial consultant is usually a recognized expert who is available for information and advise on specific types of technical problems. When a firm of consultants begins to do experimental work, the organization evolves into a private consulting laboratory or a commercial research laboratory.

The consulting laboratories have well established reputations based on a complete, overall knowledge of their fields. Much of their work is concerned with broad development programs. Smaller organizations of this type restrict their activities to specific problems with limited goals.

Payment for the services of these organizations is handled in various ways. The individual consultant or firm of consultants is usually engaged on a fee basis. The larger laboratories often charge on a man-hour basis, although fixed-sum contracts are sometimes used when the effort to be expended can be clearly outlined.

Industrial Laboratories

It has been customary for many years for large companies to assist customers with their technical problems. Often this help is offered free in the hope that it will lead to a new or expanded market for the company giving the technical aid. At other times, reciprocal arrangements are made for the benefit of both parties. This practice is also extended to suppliers. Companies with large laboratories assist their suppliers with technical and production problems, so as to insure the desired quality and quantity of supplies at lowest possible cost.

During World War II, there was an integrated program for the exchange of technical aid among companies working on defense contracts. This pointed up the fact that the research services of company laboratories can be sold as well as the company's products. As a result, some large industrial laboratories now actively seek contract research. The Bendix Aviation Corporation, for instance, advertises the availability of expert assistance to companies in product development.

The placing of contract research in industrial laboratories has obvious advantages when there is mutual interest between the company contracting for the work and the company performing it. If, however, there is apt to be competition between the two, or if the research is outside the special interest of the industrial laboratory, the type of service offered by commercial laboratories, universities and research institutes may be more desirable.

Universities and Their Branch Affiliates

The engineering divisions of universities and colleges, and their affiliated research foundations are the third type of outside research organization. These laboratories handle the bulk of the contract research placed by industry. The Research and Development Board estimates that universities conducted nearly 10 percent of the total research conducted in this country last year. The article "Using University Facilities for Industrial Research" (*Product Engineering* Oct, 1952) describes this operation.

There are scores of university laboratories available to industrial companies wishing to farm out research problems. Some of the small liberal arts colleges restrict their efforts to fundamental or basic research, and, in so doing, perform a vitally important role in the national economy. At the other extreme are state-supported universities that are bound by their charters to carry on applied research and even testing, as a part of their regular operations. Some universities have research divisions and foundations that operate independently of the parent institution; most universities, however, regard such activities as an essential part of their educational function.

A company wishing to engage the services of a university laboratory will find a variety of arrangements possible. The establishment of a fellowship or a grant-in-aid has been traditional. Fellowships are still used, but the great volume of university research now conducted is contracted through their formalized research organizations. For instance, in 1951, the Engineering Research Institute of the University of Michigan conducted more than $3-million worth of sponsored research for industry and government. Similarly, the Research Division of the New York University College of Engineering totalled more than $1¾-millions.

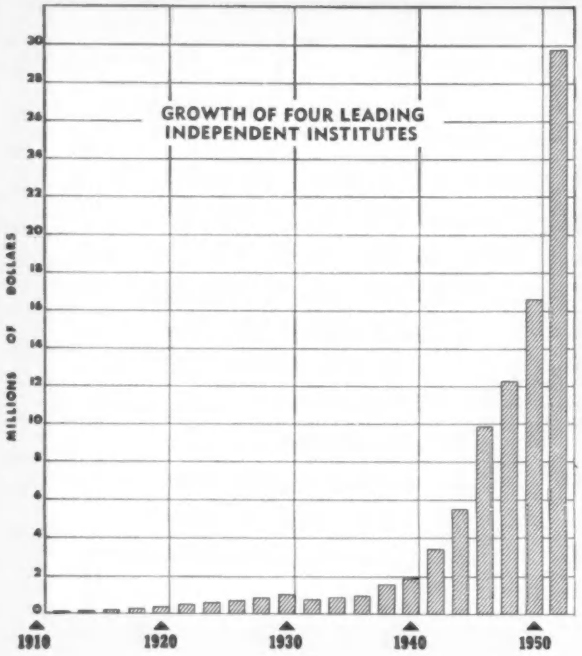
The Purdue Research Foundation is a typical university research organization. It negotiates contracts and supplies financial management and patent assistance in connection with industrial and governmental research contracts. All of the research the Foundation administers is performed by faculty members and graduate students in regular university facilities. There are about sixty organizations that have many features in common with the Purdue facility.

The Division of Industrial Cooperation at Massachusetts Institute of Technology illustrates another type of arrangement. The supervisory or senior personnel are professors in the Institute, but many full-time research men without faculty status, as well as graduate students, take part in the projects. Research, however, is carried on in the regular laboratories.

Research branches of other schools exhibit even more independence from the parent institution. The Armour Research Foundation, although affiliated with the Illinois Institute of Technology, is almost always classed among

WHAT CONTRACT RESEARCH CAN DO FOR INDUSTRY

(1) Improve products.
(2) Adapt products for new markets.
(3) Develop new products.
(4) Improve existing materials.
(5) Formulate new materials.
(6) Find substitutes for expensive or critical materials.
(7) Discover new markets.
(8) Solve production difficulties.
(9) Simplify manufacturing processes.
(10) Reduce production costs.
(11) Develop labor-saving machinery.
(12) Simplify quality control.
(13) Create values from wastes.
(14) Evaluate diversification or expansion plans.
(15) Establish basis for long-range progress.



WHEN IS CONTRACT RESEARCH HELPFUL?

(1) When a company has no laboratory or research staff of its own.
(2) When a problem is too complex for a company's existing research facilities.
(3) When a problem is outside the interests and background of a company's research staff.
(4) When a company's research activities have to be expanded temporarily.
(5) When it is desirable to get an outside viewpoint or fresh ideas.
(6) When a research program has to be started or continued while a company is building or enlarging its own research laboratory.
(7) When a multiplicity of scientific talent is required.
(8) When a technical manpower shortage prevents formation or expansion of a company's research staff.
(9) When research can be conducted at less cost than in company facilities.

the independent research institutes and foundations. It performs applied industrial and governmental research in its own laboratories with its own full-time staff.

Independent Research Institutes

The terms "independent research institute" or "independent research foundation" refer to organizations that conduct research for industry or government on a nonprofit basis. They are usually endowed or privately subsidized, have philanthropic motives and are independent of both industrial corporations and government. Some, such as Armour, have nominal ties with universities.

The independent institutes alone conduct an appreciable share of the country's research business. The National Research Council, in a report entitled "Applied Research in the United States," (March, 1952) establishes the annual volume of research for industry and government being handled by these independent organizations at $35 to 40 millions. Estimates of 1952 research expenditures for the four largest research institutes—Battelle, Armour, Stanford and Mellon—total more than $29 millions.

The work of these institutions is typified by Battelle Memorial Institute which conducts research in most every field of interest to industry. A company wishing to sponsor a research program discusses their problem with Battelle officials and various members of the Institute's technical staff. The problem is clearly defined and the objectives stated. If the Institute does not have prior commitments in the field of interest, and if the problem lends itself to research, a program proposal is drawn up and submitted to the prospective sponsor. Once the program has been agreed upon by both parties, the cost and time involved in conducting the research can be estimated with a fair degree of accuracy. These figures are made a part of the contract, so that the sponsor knows his commitments in advance.

The cost of a research study at Battelle is determined by the scope and duration of the project. Costs consist of charges for the services of research and supervisory personnel and their technical and nontechnical assistants, materials, the use of depreciable equipment and undistributed expenses. These add up to an expenditure of from $5,000 to several hundred thousand dollars for a single study. Battelle, like most of the other research institutes, does not accept testing assignments that could be handled by commercial testing laboratories, nor does it take on consultant work.

At Battelle a research project is regarded as the responsibility of the Institute as a whole. It is assigned to the group or groups best qualified to handle it, and any one on the staff may be called upon when special problems arise.

During the course of the research study, there is constant liaison with representatives of the sponsoring company. Arrangements are made in advance for the type of research reports that will be mutually advantageous. These may be in the form of monthly letter reports, topical reports, quarterly reports or otherwise, as the sponsor may wish.

Any degree of confidence desired by the sponsor can be maintained. If the work leads to patentable information, Battelle will, at the request of the sponsor, apply for patent protection and assign resulting patents to the sponsor.

What "Outside" Research Offers Industry

The development of the various types of organizations that handle contract research is exceedingly fortunate. Were it not for these organizations, many companies would be unable to engage in research. Technology is so complicated today that the simplest technical problems of industry may require vast investments in research

PRINCIPAL COMMERCIAL RESEARCH LABORATORIES

Frederick S. Bacon, Watertown, Mass.
Gustavus J. Esselen, Inc., Boston
Evans Research and Development Corp., New York City
Miner Laboratories, Chicago, Ill.
Arthur D. Little Inc., Boston, Mass.
Foster D. Snell, Brooklyn, N. Y.
Comstock Wescott, Cambridge, Mass.

PRINCIPAL INDEPENDENT RESEARCH INSTITUTES

Armour Res. Foundation, Chicago, Ill.
Battelle Mem. Inst., Columbus, O.
Franklin Institute, Philadelphia, Pa.
Mellon Institute for Industrial Research, Pittsburgh, Pa.
Midwest Res. Inst., Kansas City, Mo.
Southern Research Institute, Birmingham, Ala.
Southwest Research Institute, San Antonio, Tex.
Stanford Research Institute, Palo Alto, Calif.

Experimental foundry at Battelle Institute illustrates the type of facilities required for effective research in metal casting and alloy development.

equipment, organization and technical manpower for their solution. Many companies do not have the financial resources needed to equip and staff a laboratory adequate to do effective research. But by taking their problems to a research institute, a private consulting laboratory or a university, they can obtain the advantages of a large well-equipped and staffed laboratory without capital expenditure.

Although contract research is the *sine qua non* of many small businesses, large companies with laboratories of their own make greater use of outside research organizations than do small concerns. As do many moderate-size companies, the large firms use contract research as a supplement to their own laboratory activities, thereby saving the expense of facilities and personnel for which there would be only limited use. Outside research is also a medium for introducing new ideas to company research. In many large companies, this "fresh thinking" approach is a matter of policy.

Effectiveness of Contract Research

Companies contemplating the use of outside research facilities naturally wish to know something about the probable success of a sponsored project. The chances of a research project paying off depends on what is meant by "paying off." Most projects are set up to amass information that will be useful in day-to-day production or to answer some question that will influence a company's future planning. Research work almost always results in useful information and, in this sense, research almost always pays off. Even if the information obtained is completely negative—just the opposite of what the sponsor anticipates—it still has some practical value. The fulfillment of the terms of the contract is the ethical criterion as to whether the services rendered are in keeping with the values received. No reputable research organization will enter into a contract that gives misleading impressions.

The relatively new sciences of engineering economics and operations research help make research more efficient and productive. Engineering-economics studies indicate in advance whether a technical goal is a worthy one economically, and operations-research studies make it possible to determine whether a proposed program is the one most likely to promote a company's objectives. Battelle Institute has coined the term "operation diagnosis" to describe its analytical approach to evaluating research opportunities and research planning. This concept implies the abandonment of whims or hunches regarding where research should be applied and how it should be directed. Instead, it stresses the development of programs along lines established by scientific analysis.

Merely from the diversity of their experiences, many of the laboratories that handle contract research are in excellent positions to advise and counsel companies on the broad aspects of research plans. Frequently, a pending development in a field of technology seemingly far removed from the interests of a company will have a more profound effect on the future of the company than anything currently under study. The independent laboratory, with its knowledge of what is going on in many fields of science, can therefore point out to sponsors potentially profitable opportunities.

Cost of Sponsoring Research

There is no accurate rule of thumb by which one can estimate the cost of a contract research project. The nature of the problem and its degree of complexity are the main governing factors. Dr. Work of New York University, states that a minimum program in a university laboratory may cost from $10,000 to $20,000. Clyde Williams, Director of Battelle, recommends that small businesses think in terms of expenditures of $10,000 to $15,000 a year continued for several years.

NACA Photo

Model studies of rocket components are typical of research being conducted at the many government laboratories.

THE PRINCIPAL

DEPARTMENT OF THE AIR FORCE

Air Force Missile Test Center Long Range Proving Ground	Patrick Air Force Base Cocoa, Fla.
Arnold Engineering Development Center	Tullahoma, Tenn.
Cambridge Research Labs.	Boston, Mass.
Edwards Air Force Base	Muroc, Calif.
Electronics Dev. Center	Rome, N. Y.
Holloman Air Force Base	Alamogordo, N. Mex.
Wright Air Dev. Center	Dayton, Ohio

DEPARTMENT OF THE ARMY

Chemical Corps	
Army Chemical Center	Edgewood, Md.
Dugway Proving Ground	Dugway, Utah
Corps of Engineers	
Engineer Res. & Dev. Labs.	Fort Belvoir, Va.
Signal Corps	
Signal Corps Eng'g. Labs.	Fort Monmouth, N. J.
Ordnance Corps	
Aberdeen Proving Ground	Aberdeen, Md.
Detroit Arsenal	Centerline, Mich.
Frankford Arsenal	Philadelphia, Pa.
Picatinny Arsenal	Dover, N. J.
Redstone Arsenal	Huntsville, Ala.
White Sands Proving Grounds	Las Cruces, N. Mex.

Industry Can Use GOVERNMENT

JOHN C. GREEN
Director, Office of Technical Services
Department of Commerce

THE use of government sponsored research by private industry is a relatively new thing. Only in the last few years have business men become aware that they can "cash in" on information amassed in federal laboratories.

Before World War II, government research was an almost negligible effort, as far as industry awareness was concerned. Industry either disregarded it or viewed it with tolerance as a minor activity. However, when the war prompted the marshalling of technical talents and facilities, science became an instrument of warfare. Then, after V-J Day, when the military forces were cut back, research efforts were maintained at a high level. The public, military services and Congress realized that continued scientific research and development were necessary to avoid technological obsolescence in future combat. This policy has been followed on a stepped-up basis since Korea.

During 1953, the federal government will spend a little more than $2-billion for scientific research and development. Most of this expenditure is of necessity in the interest of national defense, but much of the resulting technology will eventually be of value to industry. In fact,

GOVERNMENT RESEARCH LABORATORIES

ATOMIC ENERGY COMMISSION

Radiation Laboratories	Berkeley, Calif.
Ames Laboratory	Ames, Iowa
Argonne National Laboratory	Chicago, Ill.
Brookhaven National Laboratory	Upton, L. I., N. Y.
Knolls Atomic Power Laboratory	Schenectady, N. Y.
Los Alamos Scientific Laboratory	Los Alamos, N. Mex.
Mound Laboratory	Miamisburg, Ohio
Oak Ridge National Laboratory	Oak Ridge, Tenn.
Institute of Nuclear Studies	Oak Ridge, Tenn.
Sandia Laboratory	Albuquerque, N. Mex.

DEPARTMENT OF COMMERCE

National Bureau of Standards	Washington, D. C.
National Bureau of Standards	Corona, Calif.
National Bureau of Standards	Los Angeles, Calif.

CIVIL AERONAUTICS ADMINISTRATION

Technical Dev. Center	Indianapolis, Ind.

DEPARTMENT OF THE INTERIOR

Bureau of Mines

Eastern Experiment Station	College Park, Md.
Metallurgical Division	Boulder City, Nev.
Northwest Electro Dev. Lab	Albany, Ore.

Bureau of Reclamation

Branch of Design	Denver, Colo.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Ames Aeronautical Laboratory	Moffett Field, Calif.
High-Speed Flight Res. Station	Muroc, Calif.
Lewis Flight Propulsion Labs	Cleveland, Ohio
Langley Aeronautical Labs	Langley Field, Va.

DEPARTMENT OF THE NAVY

Bureau of Aeronautics

Naval Air Development Center	Johnsville, Pa.
Naval Air Materiel Center	Philadelphia, Pa.
Naval Air Missile Test Center	Pt. Mugu, Calif.
Naval Air Test Center	Patuxent River, Md.

Bureau of Ordnance

U. S. Naval Ordnance Labs	White Oak, Md.
U. S. Naval Ordnance Plant	Indianapolis, Ind.
U. S. Naval Ordnance Test Station	Inyokern, Calif.
U. S. Naval Proving Ground	Dahlgren, Va.
U. S. Naval Torpedo Station	Newport, R. I.

Bureau of Ships

David W. Taylor, Model Basin	Carderock, Md.
Material Laboratory	Brooklyn, N. Y.
Engineering Experiment Station	Annapolis, Md.
Navy Electronics Laboratory	San Diego, Calif.

Office of Naval Research

Naval Research Laboratory	Washington, D. C.

RESEARCH DATA

some of the results of post-Korean research are already available. This $2-billion research "package" now supports about two-thirds of the nation's total research effort and uses more than 50 percent of the research capacity.

Eighteen federal departments and agencies perform or supervise the research. Their laboratories and experiment stations are located at strategic points all over the country as tabulated above. Added to these are industrial research laboratories and universities which hold more than 100,000 research contracts with the government.

Federal research efforts stretch into every field of human activity. Medical research is done by the Federal Security Agency and the Veterans Administration, fundamental chemical and electronic research by the Office of Naval Research, physics research and studies in a score of other fields by the National Bureau of Standards. The beginning of what is expected to be a major governmental effort to sponsor fundamental research has been made by the National Science Foundation.

The bulk of military services' research is directed toward the development of equipment, weapons and supplies. General practice is to support pure research only when the result appears to be applicable to an end-product useful to the military. This "rule" of emphasizing applied research is not without its exceptions. An extensive program supported by the Office of Naval Research is taking place at many of the nation's universities. Also of considerable significance is the increased interest in basic research exhibited by the armed forces. There is a sharp awareness in all branches that new weapons, as contrasted with modifications of existing weapons, must be based upon fundamental exploration in new fields, or the pushing back of boundaries of existing fields.

Military research is expensive, but the end results often save money. For example, the Army Signal Corps developed a new field telephone wire that costs $87 per mile, compared with $116 per mile for the type used in World War II. This wire not only weighs one third as much as its predecessor, but also makes possible a 20 percent increase in talking range and more rapid stringing than the old wire. The resultant economies are re-

flected in a saving of manpower in the field, about 11,000 tons of steel and more than one and one-half million pounds of copper per year. The cost of research and development on the new wire was $288,000.

Using Federal Research Data

To assist in the job of making the results of government research available to industry, the Commerce Department's Office of Technical Services (OTS) is set up to do three things: (1) Help industry benefit from the government's research expenditures, (2) assist in breaking technical production bottlenecks, and (3) keep industry informed of the latest production techniques.

Each research project results in a technical report. OTS gathers all those that are free of secrecy restrictions, stockpiles them, and furnishes copies at nominal cost to private industry. They present not only the results of research studies but also the full details on equipment used and the steps by which the results were attained.

Thousands of these reports are issued each year. Collectively, they are a valuable source of technical information that industry, particularly the smaller companies, can dip into for the complete story on how to establish a new process, manufacture a new product, or change an old technique to a new and more productive one. A typical example is a midwest machine tool builder who commented: "We have made good use of reports on shell molding, cold drawing of steels, and productivity reports by the British teams on textiles, foundries and metal finishing. On one occasion, technical advice from the Office of Technical Services on forging of surgical instruments was helpful in planning the manufacture of some intricate machine parts."

Government Research Publications

To inform industry of these research reports as soon as they become available, the OTS issues a monthly publication called the "Bibliography of Technical Reports," which lists the titles of the latest reports and gives an abstract of each. Subscription rate is $5.00 per year. By studying these bibliographies the head of an industrial concern can keep abreast of developments in this vast outflow of government research and pick out any items that are of potential use to him.

Unclassified research data in the field of atomic energy are published by the Atomic Energy Commission in "Nuclear Science Abstracts." Reports listed in this monthly publication are available from the Office of Technical Services.

Experience has shown that many production difficulties can be solved by government researchers. Thus, throughout a period of years, OTS has built up a staff of trained technologists who act in an advisory capacity. They also know who in government are specialists in a wide variety of fields. If a company's problem is how to cut down rejects in a process, improve waste disposal, reduce losses in scrap, find new products for its machinery or locate machinery to produce a new product, the OTS technical advisory service can usually supply the answer.

The Office of Technical Services also keeps in touch with the Department of Defense and other government agencies, reviews the latest production techniques used by them, and prepares brief summaries. This information is put out in the form of brief pamphlets called "Small Business Technical Production Aids."

Another service rendered by the Department of Commerce concerns patents. A "Register of Patents Available for License or Sale" is maintained by the Patent Office. Any patentee interested in prospective manufacturers can have his patent entered on this Register and the fact publicized in the weekly "Official Gazette." Manufacturers making inquiry for assistance in finding new products for manufacture can obtain lists of patents from the Register relating to any particular subject. Inquiries by manufacturers with respect to specific patents are referred to the patent owners.

There is also available a listing of over 3,500 Government-owned patents published by the Government Patents Board. More than 2,300 of these are available for free licensing without payment of any royalty.

Record cards have been prepared listing the wholly-owned Government patents, and sets of these cards, which contain abstracts of the inventions. have been placed in all the regional and field offices of the Department of Commerce. The sets are also available for purchase through the Office of Technical Services.

The size of the government's research operation is now such that it cannot be ignored. A substantial part of this work is in fields where the initiative does not rest with private industry. Atomic energy is an example. In the Atomic Energy Act of 1950, Congress made this field a monopoly of the federal government, thereby keeping private industry on the side lines. Even now, industry is rarely allowed to perform significant atomic research on a cooperative basis with the Atomic Energy Commission. In another instance, government entered the field of synthetic rubber research when the exigency of national security required a greater effort than industry was able to muster in a short time. A third case in point is titanium research.

These illustrations are not meant to imply that the federal government must necessarily dominate industry in the research and development field. Through participation in government-industry advisory panels, industry can offer sage counsel and exercise a restraining hand. Together with government, industry can plan many of the programs and policies governing work to be undertaken. At the same time, they can make sure that research conducted by or for the federal government will be of maximum benefit to industry. And finally, because industry is helping to foot the bills for this research, it is only natural that they utilize the government services and publications set up to disseminate the results of this vast research program.

TECHNICAL AIDS RENDERED BY THE OFFICE OF TECHNICAL SERVICES

Technical Reports Newsletter. **A monthly bulletin highlighting business opportunities arising from non-confidential Federal research.**

Bibliography of Technical Reports. **A medium for notifying the public of newly available Federal reports.**

"PB" Collection. **A collection of 150,000 technical reports from wartime and postwar research conducted by U. S. agencies and abroad.**

Technical inquiries **are answered with information from Federal and other nonconfidential research sources.**

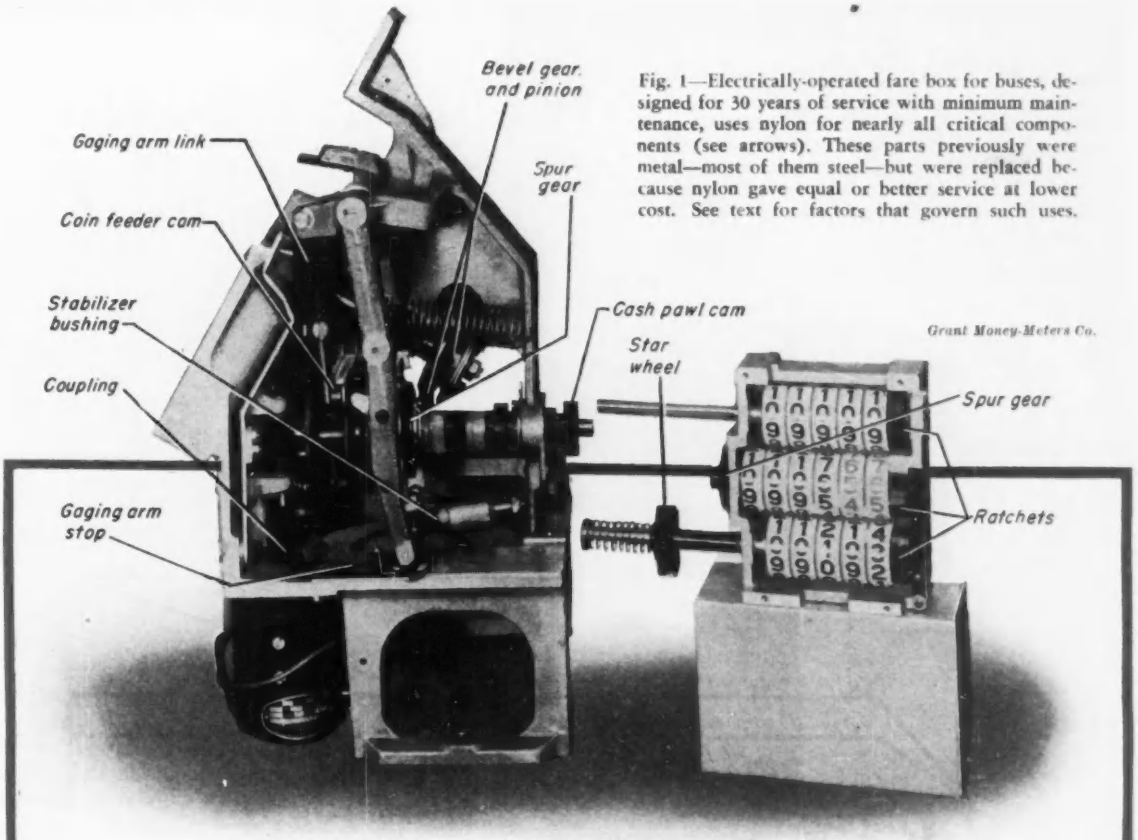


Fig. 1—Electrically-operated fare box for buses, designed for 30 years of service with minimum maintenance, uses nylon for nearly all critical components (see arrows). These parts previously were metal—most of them steel—but were replaced because nylon gave equal or better service at lower cost. See text for factors that govern such uses.

Don't Under-rate Nylon For Mechanical Components!

JOHN HOLT, Pres.
WILLIAM CHADBOURNE, V. P.
Danielson Manufacturing Company

DESIGN ENGINEERS are learning that nylon is more rugged and capable of transmitting much more power than they realized previously. In fact, tests have proved that in some applications, it out-performs and outlasts any other material—plastic or metal.

When using nylon for load carrying members, success or failure is governed by: (1) Basic soundness of the application; (2) proper design; and (3) good molding technique.

The primary reasons for using nylon parts are their lower cost, inherent lubricity, excellent resistance to wear and abrasion, and/or excellent coefficient of friction. With heavy duty applications, other properties may be equally important. The most outstanding of these is its resilience. However, with parts such as gears use of this plastic may be justified because of its ability to absorb vibration and reduce noise, notwithstanding other advan-

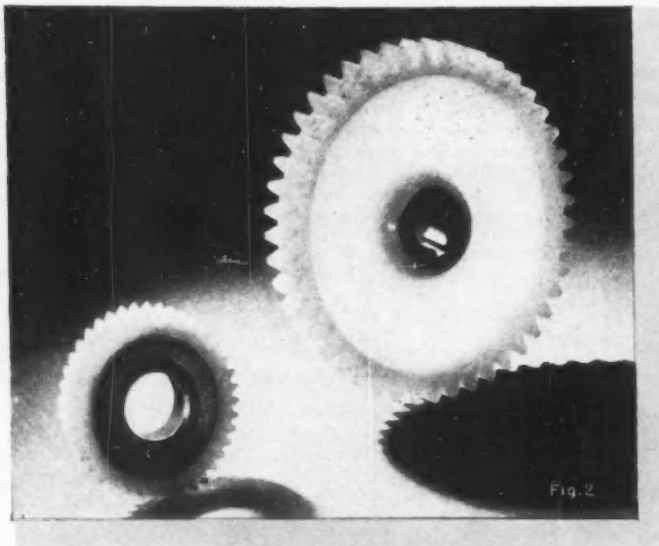
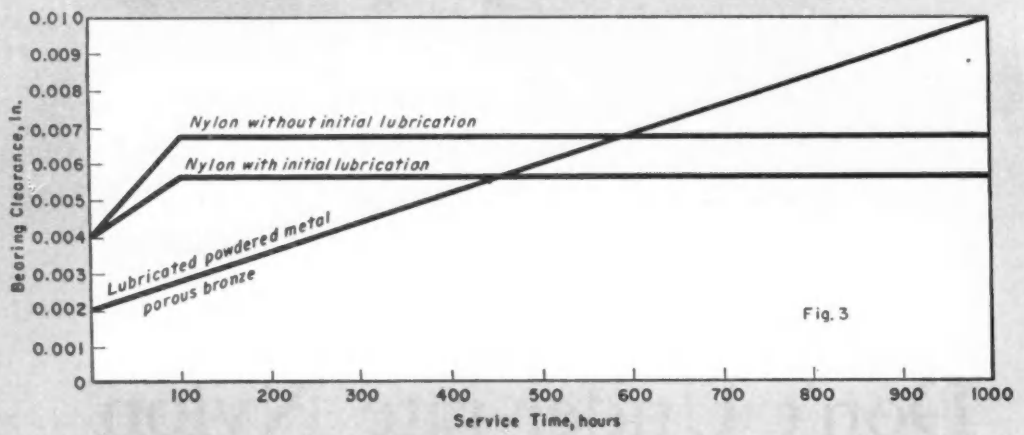


Fig. 2—Typical molded gears which are capable of replacing metallic components. Spur gear, right, was designed to transmit 1¼ hp at 1,200 rpm. To provide adequate strength without increasing size of steel insert, web thickness is less than that of hub. Strength of nylon is particularly sensitive to design and molding techniques. Addressograph-Multigraph Corp. uses 33 deg. helical gear, left, in duplicating machine for quiet operation and to provide safety device in the event of overloads.

Fig. 3—Wear of nylon bearings is almost zero after initial break-in period. Curves also show the advantages of using initial lubrication.



tages that may be gained as well.

Experienced designers and molders have learned that nylon is a distinct engineering material. Since many of its properties and characteristics are unique and not fully understood, they found that the one reliable way to evaluate an application is on the basis of past experience.

In lieu of this, however, some indication can be derived from a critical study of physical and mechanical properties. This discussion is concerned only with du Pont's FM-10001 compound since it has the highest tensile and compressive strength, the best heat and abrasion resistance, is the most rigid and the least expensive of all standard compositions. Its tensile strength at room temperature is 10,900 psi; flexural fatigue strength based on constant load and constant deflection is 6,000 psi; modulus of elasticity at room temperature is 400,000 psi. Data like this, however, should be used only as a general guide.

On a cost basis, additional savings are often possible by replacing assemblies of multiple components by a single molding. No general rules can be made. Each application should be evaluated individually.

Many bearing applications are made because nylon can operate indefinitely without a lubricant if designed properly. Several installations are now running at 20,000 rpm with only a film of light oil at the time of installation to reduce the wear rate during the break-in period. In service, nylon gears and bearings do not usually fail from abrasive wear. When failure occurs it is generally caused by excessive loads and/or temperatures. Continuous lubrication with light oil may often be desirable. This is not for lubrication, but mainly to remove foreign particles as well as heat. Water can be used instead of oil but it nearly always means a lower load capacity and shorter life.

Design Considerations

Although the design considerations for heavy duty parts are basically the same as those of lightly loaded components, the importance of factors such as tolerances and running clearances is magnified considerably. This

is a many sided problem. For one thing, dimensions need not be controlled as closely as would be required with metallic parts because the material is resilient. It yields slightly at the surface, but shows little wear over extended periods in thermally stable installations.

An example of the common tendency to overdesign nylon is illustrated by the helical gear in Fig. 2. Unknowingly, it was produced without meeting its minimum allowable specifications. The outside diameter was 0.004 undersize, runout was 0.004 compared to the 0.002 specified, and the helix angle was 36 instead of 33 degrees. These discrepancies were not discovered until many gears had been operating satisfactorily for more than a year. It was then recognized that the tolerances were too rigid and the part is still being made and used as produced originally.

Steel inserts such as those in the helical and spur gears are not generally recommended. They should be used only when a keyway is necessary. Under these circumstances a nylon keyway is not adequate and inserts are required. Diamond knurls are usually adequate for joining the two materials. The size of insert should be selected with the following factors in mind: (1) Avoid large, heavy nylon sections for best strength and sound moldings; and (2) ratio of steel-to-nylon should be larger for severe working conditions than required, in general, for service involving moderate type loads.

Probably the most difficult phase of the tolerance problem is the dimensional stability of parts in service. Five operating conditions are involved: (1) Temperature range; (2) humidity; (3) speed; (4) load; and (5) stability of the part as produced.

The expansion of nylon with changes in temperature is substantially greater than that of metals. Its coefficient of linear expansion is 5.5 x 10^{-5} in. per F compared to 1.0—2.0 x 10^{-5} for steels. The same is true with humidity. However, when the clearance between two or more parts is critical and these expansion rates are excessive, one possible solution is to make both parts from nylon. Typical applications of this type will be given later.

Speed and load become important if adequate clearances and provisions for heat dissipation are not provided. Bearings designed without such consideration have seized in five to ten seconds. On the other hand, well designed bearings in similar applications were superior to any known material on the basis of cost, performance and

Table I — Test Data for Frictional and Wear Properties

Materials	Lubricant	Load lb/sq in	Rubbing Velocity ft/min	Rate of Wear ft/½ hr	Average Coefficient of Friction
Nylon against cold-drawn steel	Water	1,050	156	0.0092	0.494
Nylon against cold-drawn steel	SAE No. 10	1,550	156	0.005	0.140
Nylon against nylon	Dry 88 Percent R.H.	1,050	156	0.0016	0.039 to 0.099
Nylon against nylon	Dry 88 Percent R.H.	550	156	Immeasurable	

E. I. du Pont

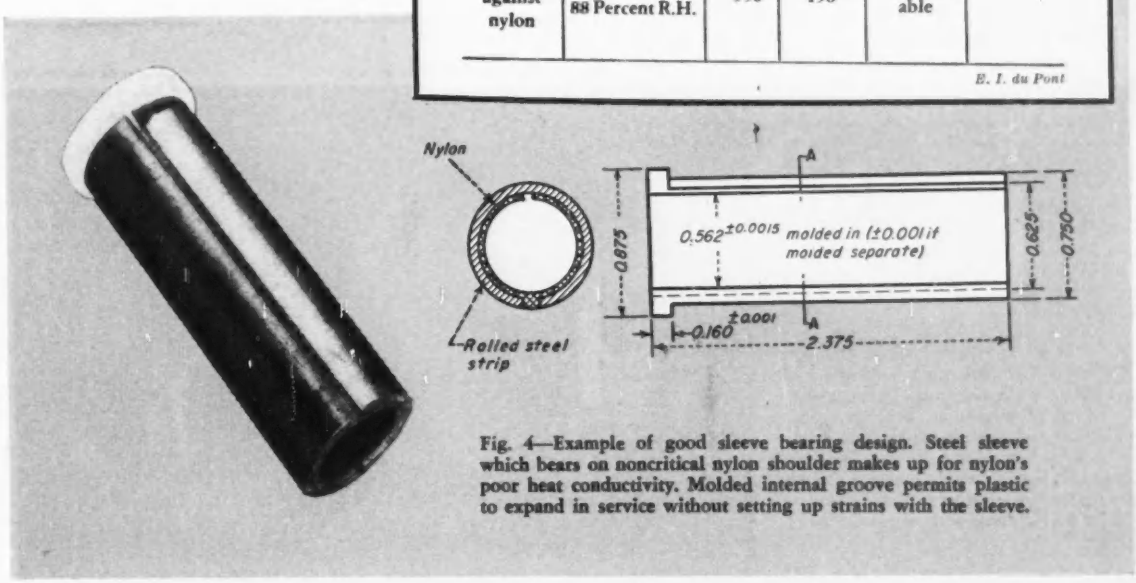


Fig. 4—Example of good sleeve bearing design. Steel sleeve which bears on noncritical nylon shoulder makes up for nylon's poor heat conductivity. Molded internal groove permits plastic to expand in service without setting up strains with the sleeve.

Table II—Theoretical Safe Working Stresses for Nylon Gears

Pitch Line Velocity ft/min	Safe Working Stress lb/sq in.	Pitch Line Velocity ft/min	Safe Working Stress lb/sq in.
100	4,500	1,000	2,250
150	4,071	1,500	2,029
200	3,750	2,000	1,909
250	3,500	2,500	1,833
400	3,000	3,000	1,781
500	2,786	4,000	1,715
800	2,400		

E. I. du Pont

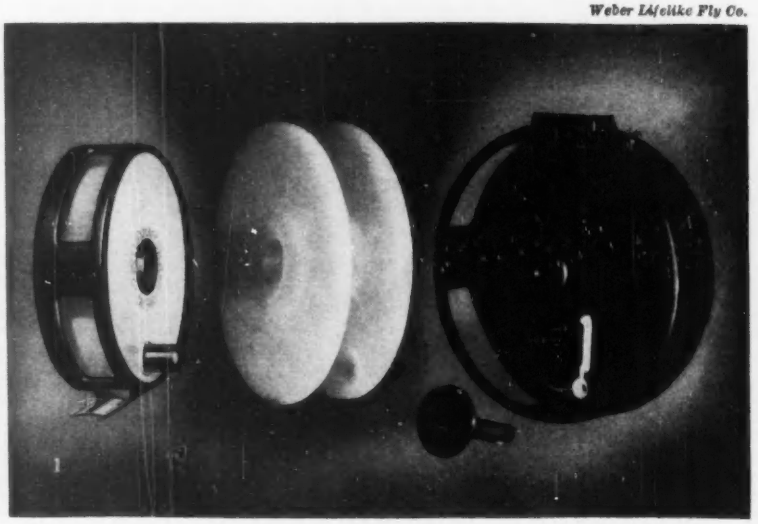
life. In general, the tolerance required in a sleeve bearing is three to four times that acceptable with the more common bearing metals. However, the excellent wear-resistance of nylon can often offset this condition. For example, Fig. 3 shows the wear in a continuously lubricated porous bronze bearing with initial tolerance of 0.002 and two nylon bearings with tolerances of 0.004. These curves show that the effect of the larger design tolerance is offset after about 460 hr of operation with initial lubrication and 600 hr without initial lubrication. Initial lubrication consisted of coating the bearing with a film of light oil before assembly. No lubricant was otherwise supplied to either plastic bearing.

Indications of the coefficient of friction of nylon are given in Table I. These data were taken from a series of tests with a Neely boundary film machine under various controlled conditions of loading and at rubbing velocities ranging from about 150-900 ft per minute. Combinations of nylon-against-nylon have the lowest coefficient of friction and the lowest wear rate and nylon-against-steel is almost as good. In the Neely machine, the specimen is in contact with the wear plate for about 10 percent of the cycle and frictional heat is therefore eliminated. In practice, frictional heat can cause seizure in a few seconds, unless this heat is dissipated. One commonly used method of providing this dissipation is to support a thin nylon bearing in a metal housing, the reduced wall thickness of nylon giving many times the heat-dissipation capacity of a solid bearing of the same material. There are several methods of mounting these thin sleeves in a housing; one is illustrated in Fig. 4. As a general rule, the nylon should not be press fitted since it develops strains which can cause premature failure.

On the part shown, most of the strain introduced during assembly is concentrated on the shoulder on the outside surface of the nylon sleeve where it does the least harm. The internal slot in the nylon allows the bearing to expand in service without introducing additional strains. Whether they are the result of molding techniques or assembly methods, residual strains will cause growth of the bearing or other component as soon as the temperature of the part increases. Molding strains can be reduced or eliminated by annealing. Using an oil bath for annealing bearing or other rubbing surfaces serves a double purpose. It provides dimensional stability and also the film of lubrication for the intial break-in. An experienced molder can also use annealing to get closer tolerance control. For example, the tolerance on the diameter of an 18 in. ball bearing cage was specified as 0.025 in., but the molder was able to control this dimension after annealing to within 0.017 inches.

The tolerance considerations noted for bearings also apply to gears and other mechanical components. Theoretical safe working stresses for gear teeth are given in Table II. In addition, because of their resiliency, nylon gears often leave two or more pairs of teeth in contact simultaneously. Thus, stress factors calculated with the con-

Weber Lifelike Fly Co.



1. Fishing reel shows how assembly can be simplified using all nylon parts. Small ratchet arm in case which engages molded teeth on spool is press fitted. Pin, foreground, snap fits into case to complete the assembly of these parts. Metallic adapter is attached to top of case with self-tapping screws.

2. Clutch faces with two in. OD now replace similar components made of steel. They are transmitting approximately 75 oz in. of torque at 1750 rpm. Frequency of engagement varies from 14-to-40 cycles per min, 24 hr a day. The steel parts lasted about three weeks in operation; nylon gives three to five months of service and also reduced the noise level.

(continued on page 208)

ventional equations will be quite conservative. The illustrations that follow this discussion will indicate other examples of how design techniques should be modified, to take advantage of nylon's characteristics.

Another design factor is the desirability of uniform cross-sections. It is important in minimizing distortion and stress concentration during the operation of the part as well as during the molding. Other reasons for uniform sections are that they require less material, are produced faster, are stronger and can be held to close tolerances.

Molding Techniques

Coupled with the inherent tolerance problems of the material, there are certain limitations in the art of molding itself. In the first place, there is the tolerance in the production of the tooling itself, and the shrinkage pattern of the part from the molten to the solid state, which is often difficut to predict accurately. On the general run of applications, a competent molder can come within a reasonable tolerance variation such as ± 0.003 per linear inch. Where closer tolerances are involved such as 0.002 on a dimension of less than one inch, the best solution is to produce a single cavity mold before production tooling is started. It is usually possible for a molder to hold one critical dimension to close tolerance and still maintain an attractive cost level. However, if multiple close tolerances are involved, inspection at the time of molding is impractical and is better performed as a secondary operation. Such inspection is expensive.

Because nylon is best injection molded in a cavity whereas the parts it is replacing are probably machined or formed in metal, substantial savings in the production of molds can be realized by redesigning for molding. Chamfers, for instance, are necessary in most machined parts for the sole purpose of removing burrs and ragged edges. Chamfers on both ends of a bearing or both sides of a gear nearly double the cost of producing a mold since the cavity is in both halves of the mold instead of just one.

Frequently a designer will insist that a part be completely flash-free. But any molded part must leave a ridge at the mating plane. Depending upon the design, this ridge can often be placed at such a position as not to interfere with the operation of the part. Usually, it can be held to such close limits that it can be on an operating surface, as on the external threads illustrated on the following pages. The ridges do not interfere with sealing. To avoid misunderstandings, however, the location of parting lines should be discussed with the molder.

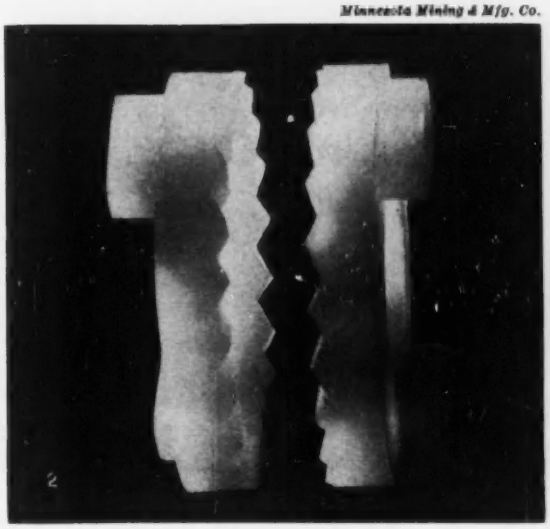
Any design which requires the machining of an operating surface increases cost, and more important, removes the tough skin found on moldings. This skin is the reason for the axiom that "if it works in a machined sample, it will work better if properly molded."

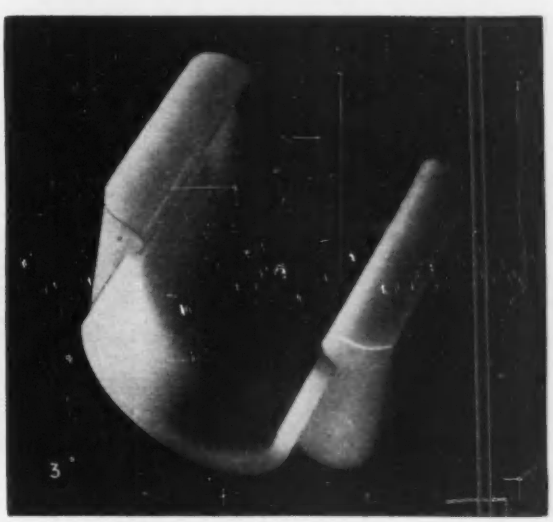
Unless the application has already been proven, it will be necessary to test the material in the application under consideration. Parts can be machined from rod stock which is available in several formulations. This method has the advantage of taking the least amount of time and also being less expensive unless a large number of pieces are required for the test. It has the disadvantage of producing a part which will have inherent strains that are difficult to remove, as well as reducing the strength of the finished product.

The second method is to machine a single cavity experimental mold from which the parts can be made to duplicate production pieces. This increases costs but at the same time has distinct advantages.

It gives the molder a chance to study the shrinkage characteristics of the part and thus control dimensions more closely if the piece goes into multicavity production. Furthermore, the molder can vary his production techniques as well as the formulations of material to get the best combination of properties. Depending on molding techniques alone, FM-10001 can be fairly hard and brittle or it can be quite ductile. An analysis of the illustrations on the following pages which were all made from this compound will show this quite readily.

Minnesota Mining & Mfg. Co.



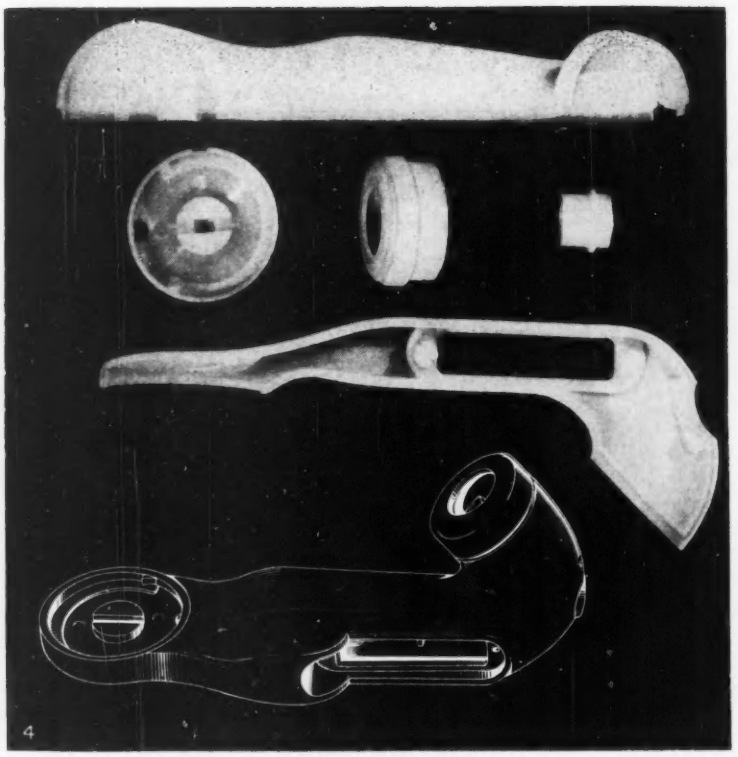


Nylon Mechanical Components (continued)

3. Sleeve bearing for loom has replaceable insert. Although speed of this machine is comparatively low, the bearing load is about 400 pounds. Recognizing nylon's resiliency, entire cavity for outer shell is in one half of the die in spite of the projecting shoulders on the inside surface.

4. Field telephone assembly, right, illustrates how careful molding can produce deep recesses with uniform cross sections. Flash on half of handle in foreground fits into molded slot on other half and is fastened with adhesive. This eliminates trimming the molding. Small moldings in center are also cemented in place.

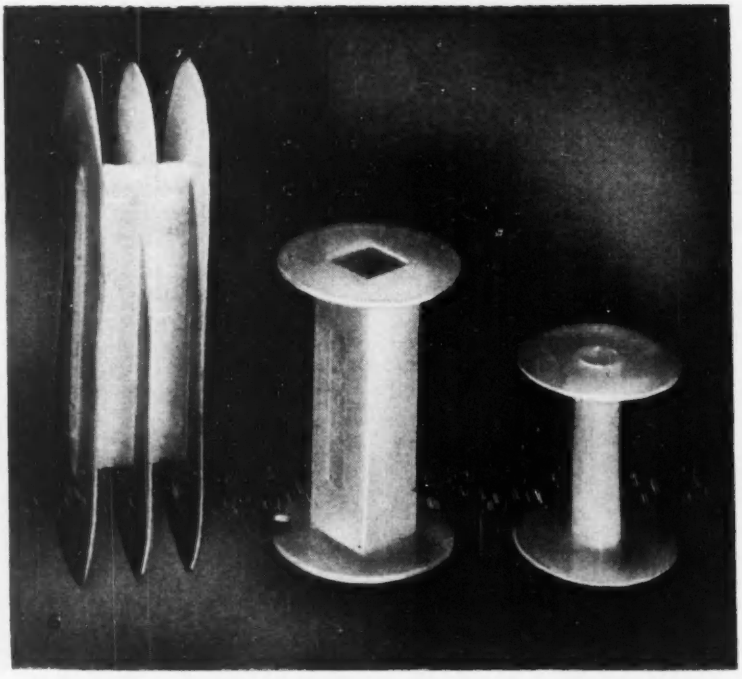
5. Speedometer gear for automatic transmission, left, uses resiliency of the material to fasten the collar by snap-fitting it over a shoulder on the shaft. Gear for conventional transmission, right, has deep recess to get uniform sections. Press-fitted plug in bottom of recess serves as thrust face.



6. Coil forms, right, illustrate strength in thin sections and how a single molding can replace an assembly of associated parts. Because this plastic can also be molded around inserts, such parts as magnetic cores can be incorporated into the forms in the molding operation, reducing assembly costs and giving improved electrical design. Other electrical uses include strain-relief grommets, solderless connectors, parts for switches other than supports for current carrying members, and a variety of insulating bushings and washers.

7. Double-end worm for knife-sharpener requires special molding technique. Two mating pinions are molded around their steel shafts. Reasons for using nylon; lower cost; quiet operation; no lubrication required; and mounting dimensions need not be precise.

8. Ball bearing cages. Assembled unit has two halves held together by steel pins which are pressed and peened. Part in foreground is one of eight segments that are assembled without fasteners into a large cage.



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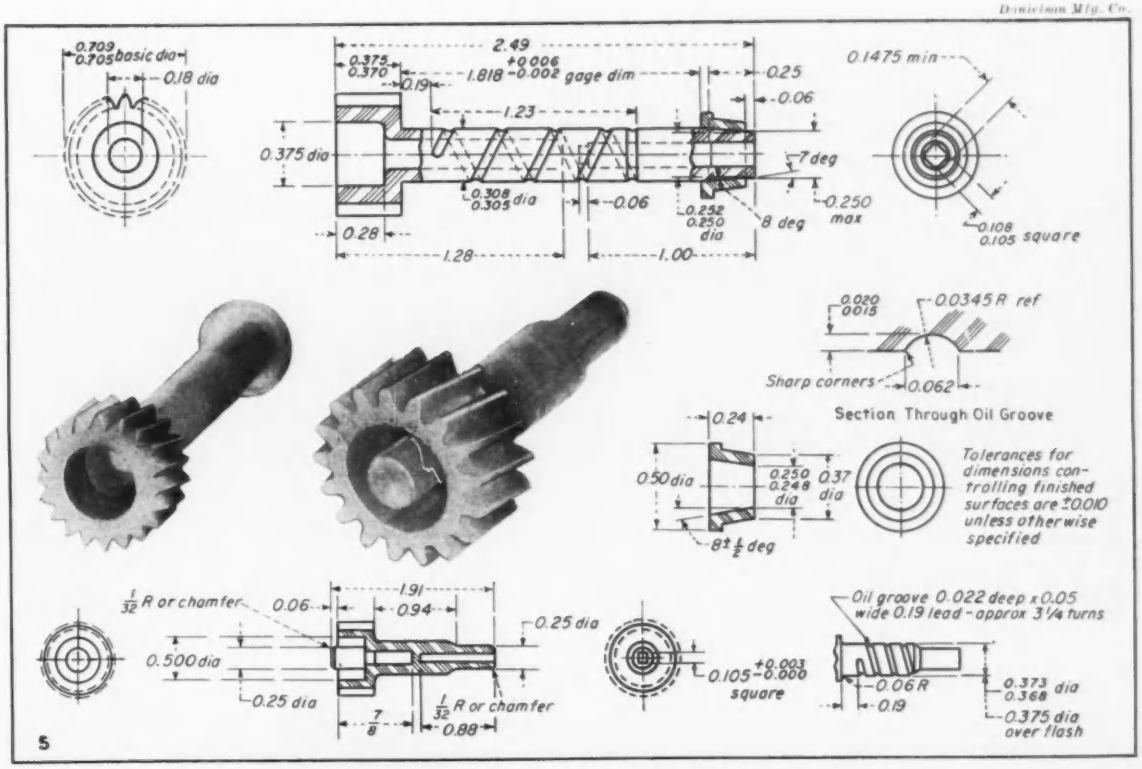
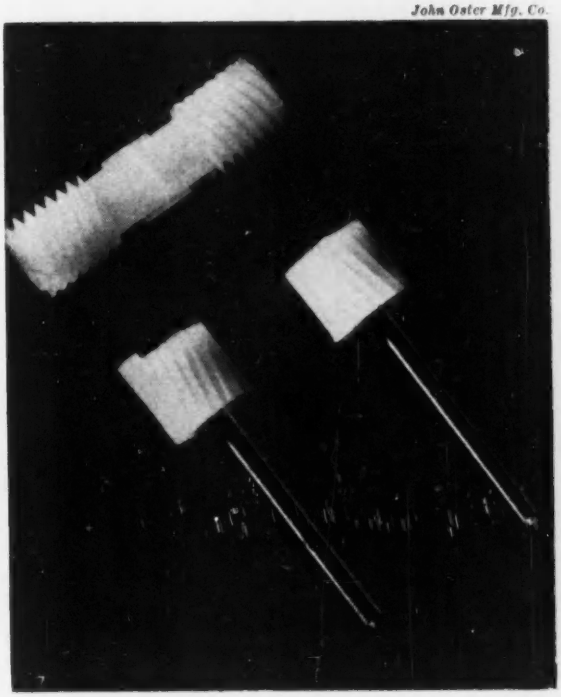
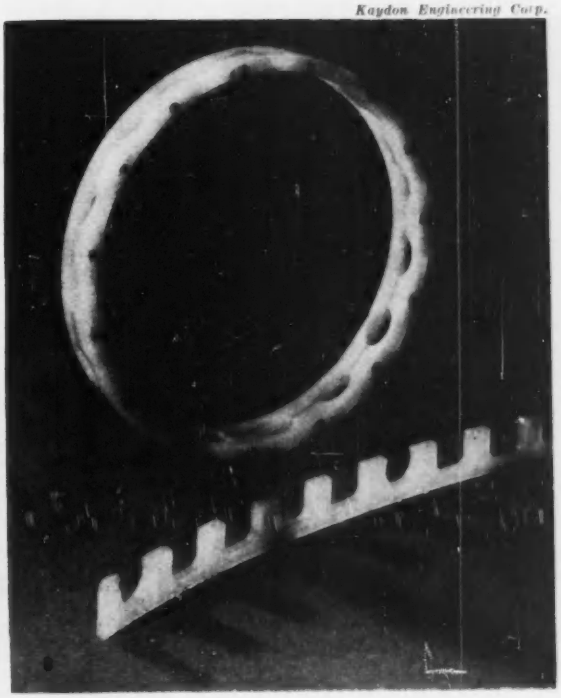
Dynacism Mfg. Co.



John Oster Mfg. Co.



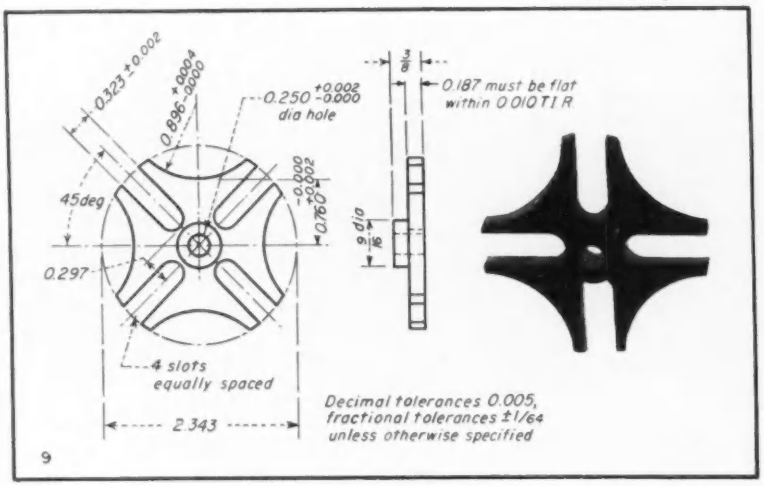
Kaydon Engineering Corp.



Nylon Mechanical Components (continued)

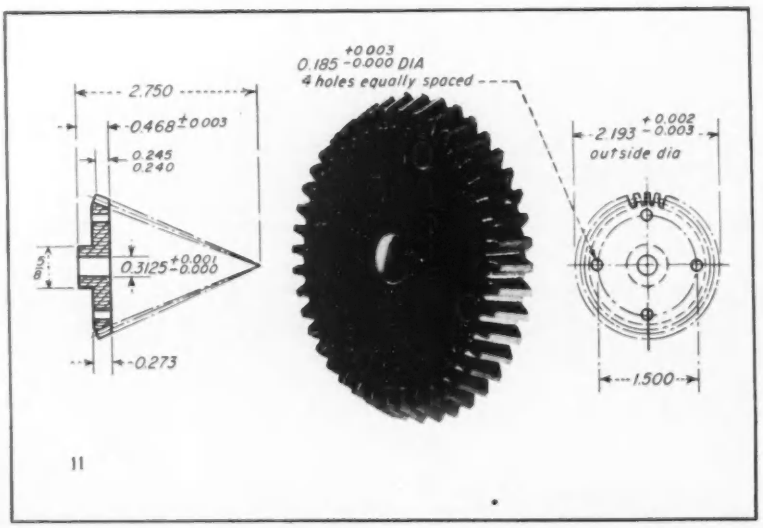
Grant Money Meters Co.

9. Making this Geneva cam from steel would increase costs considerably for several reasons: Close tolerances would require machining and grinding; hub would have to be made separately and assembled with rivets; and secondary operation like rust-proofing and burnishing would be required.



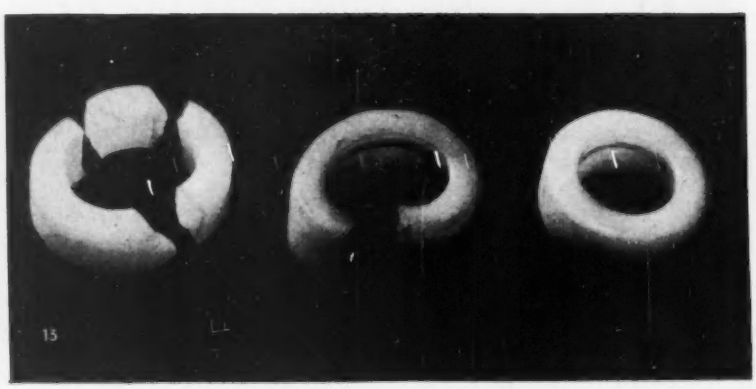
10. All parts of this windshield wiper motor except the small, external shaft are nylon. Tolerances on piston OD and cylinder ID are specified as ±0.012 each, but relative clearance is held to ±0.006 by careful molding. One O-ring at each end of piston provide air seal. Cover at left end is assembled with self-tapping screws for minimum cost and best performance.

11. This bevel gear replaced a similar part made of naval bronze. Comparisons of two gears in service showed that at the time the bronze was worn paper thin, the nylon part had no perceptible wear.

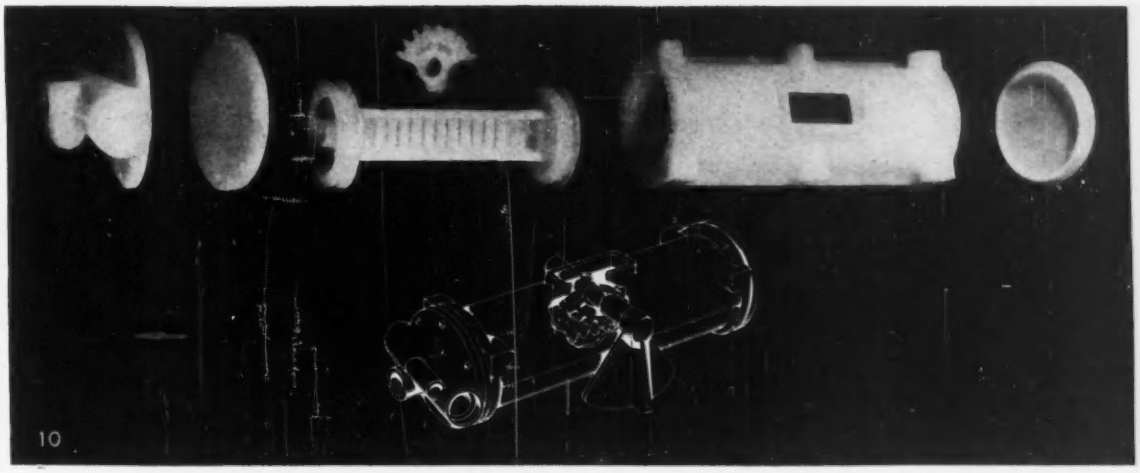


12. Good design and molding techniques were combined to get the close tolerances and large helix angle—45 deg—of this cam gear. It replaces two parts—a steel gear and a hardened and ground cam in a portable sewing machine; improves performance and saves more than 56 cents per machine, not counting the lower costs in handling, inspection and assembly.

13. These cam followers, all made from the same material, show the importance of annealing. Non-annealed part, left, shattered when subjected to impact. Improved toughness of annealed part, center, is evident after test to destruction. Intact part, right, will replace steel follower. Besides requiring no lubrication, nylon will permit cast iron track to be used instead of high grade steel.



14. Three-piece sheave replaces more expensive ball bearing component. Resiliency of the plastic is utilized to hold the assembly together without fasteners by molding a small shoulder on the long bushing. Short bushing snaps over the shoulder for locking. Nylon sheaves require no lubrication, have long life and reduce wear of steel cables. Using all nylon parts assures proper running clearances at increased temperatures and humidity and costs less than a nylon bearing in a steel pulley.



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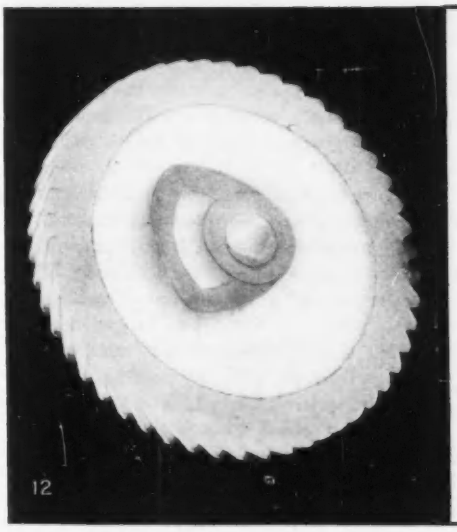
Bell Mfg. Corp.



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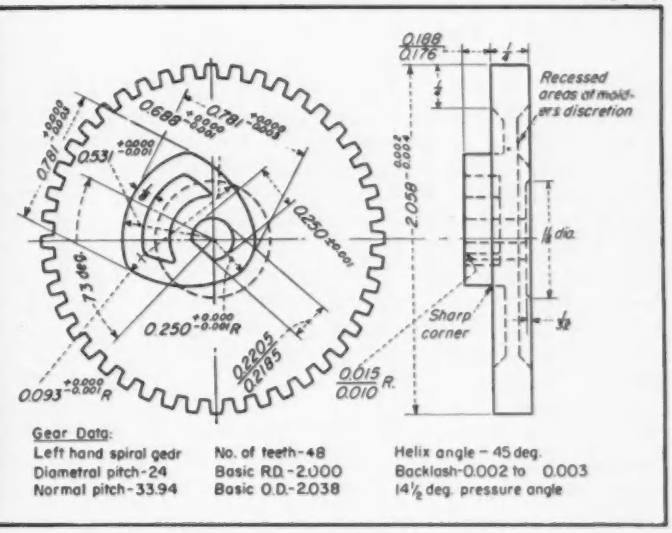

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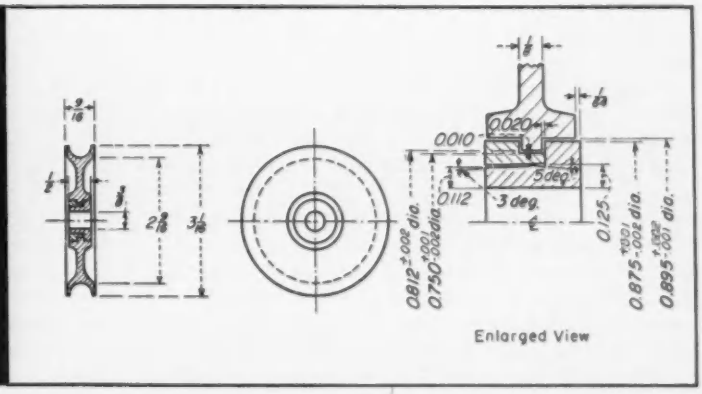


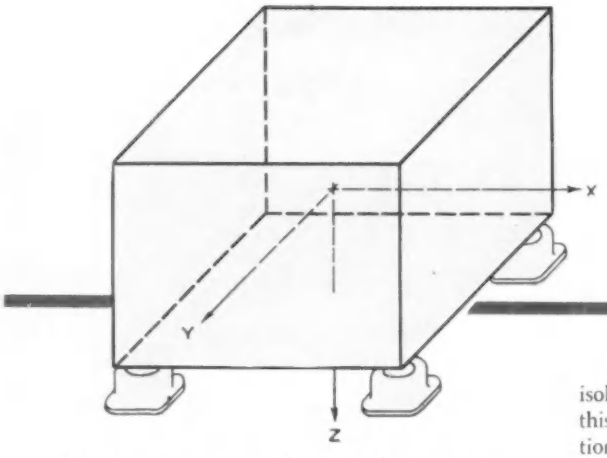


Fig. 1—Representative piece of equipment supported on resilient mounts. For simplicity, it will be assumed to vibrate only along the Z axis.

Shock or

Types of forcing functions and

J. MARKOWITZ
The Barry Corp.

EQUIPMENT that is subjected to forces transmitted through the mounting elements can be supported by three methods. It can be mounted on vibration isolators (soft mounts), shock isolators (stiff mounts), or it can be fastened down solidly without the use of any resilient mounts. The selection of the proper mount depends on the frequency and magnitude of the transmitted force and often results in a compromise that will best satisfy conflicting requirements.

At present, there are three types of applications for which the service requirements, with respect to shock and vibration, have been established:

1. High impact or ballistic shock; of which naval shipboard and submarine service is an example.

2. Medium to high impact repetitive shocks; of which mobile applications are an example. (Either in vehicular installations or equipment installed in transit cases).

3. Steady state vibration; of which equipment in aircraft is an example.

In the first two types of service, failures are caused by high impact shocks; and vibration is a secondary consideration. A single transient shock wave is imparted to the equipment and failure is instantaneous. In the third type of service, fatigue failures of equipment and components are caused by steady state vibration at frequencies in the range of 10 to 500 cps. The magnitude of the shocks to which the equipment is subjected is much less than in shipboard or mobile applications and the shock requirements become a secondary factor. Fatigue failures are caused by components being vibrated at, or near, their resonant frequency.

If the mounting devices can be made large enough it is possible to obtain isolation from low frequencies and also protection against high impact shock; but this requires more space than is usually available. As an example, the maximum allowable height of the shocks or vibration isolators in most military equipment is about $1\frac{1}{2}$ in. With this space limitation it is necessary to furnish either vibration isolators capable of isolating the lower frequencies, or shock isolators which will give protection against high impact shock. There is no isolator currently available that will do both of these jobs adequately within normal space limitations.

The two types of mounting result in opposite requirements in the basic theory of vibration isolation and shock protection. To isolate frequencies as low as 10 cps requires a soft mount with vertical resonance below 10 cycles. Isolation of high impact shock requires a stiffer mount with resonance in the neighborhood of 25 to 33 cycles per second.

In Fig. 1 is shown a typical mounting arrangement with four resilient mounts. This constitutes a system with six degrees of freedom which has natural frequencies in translation and in rotation about the *X*, *Y* and *Z* axes. There are six possible frequencies which can cause trouble when this equipment is subject to vibration. In general, it is necessary to mount the equipment so that none of these natural frequencies coincide with any forcing frequency which may cause the system to vibrate at resonance. It is desirable to keep these natural frequencies close together.

For simplicity, consider the unit to be vibrating with simple linear motion along the vertical or *Z* axis. In Fig. 2 is shown typical curves for the amplitude of vibration of the equipment when subjected to an external forcing frequency. Curve *A* shows the response of equipment mounted on soft vibration isolators having a natural frequency of 8 cps, and curve *B* shows equipment mounted on stiff shock isolators with the natural frequency of the system at 25 cps. In Fig. 3, curves *A* and *B* represent the load-deflection curves of the same isolators as in Fig. 2. In Fig. 2, mount *A*, with a natural frequency of 8 cps, begins to isolate at about 12 cycles; whereas for mount *B*, with a natural frequency of 25 cps, isolation begins at about 35 cps. Therefore, to isolate frequencies below 35 cps a soft isolator of the *A* type is required.

The nature of shock can be visualized by considering that the support to which the equipment is attached suddenly acquires a high velocity. Thus, the mounted equipment must move with the support, at substantially the same velocity and displacement. By interposing resilient shock isolators between the support and the mounted equipment, a longer period of time is allowed for the equipment

Vibration Isolators?

ranges of frequencies that can be isolated by different classes of mounts.

to acquire the maximum velocity, and the accelerations and forces on the mounted equipment are reduced. Energy is transferred to the equipment to bring the velocity of the equipment up to the velocity of the support. This energy is transferred through the isolator, which stores the energy for a short time during the shock, and then transmits it to the equipment. The *amount* of energy transferred depends upon the weight of the equipment and the nature of the shock; and is virtually independent of the characteristics of the isolator.

If the distance *R*, Fig. 3, represents the amount the isolator can deflect under a shock or impact force, then the area under the force-deflection curve to the deflection *R* will represent the impact energy stored by the isolator. The deflection of a mount under shock or impact does not give exactly the same curve that is obtained by a static load deflection test because static and dynamic properties differ; however, they are close enough to illustrate the point.

If the same piece of equipment is subjected to identical shocks when mounted on isolators of two different types, *A* and *B*, then the weight of the equipment and shock motion of the support in both instances is the same, and the area under curves *A* and *B* must be the same. For an equivalent area, the curve for isolator *A* must reach a greater peak force than the curve for isolator *B*. Therefore, greater shock is transmitted through isolator *A* to the equipment. The gradual increase of force which is characteristic of isolator *B* makes it possible to attain the same area without reaching as great a maximum force.

To achieve the lesser force of curve *B*, this isolator has a higher initial stiffness than isolator *A*; and can only isolate the relatively higher frequencies of vibration. However, it is these frequencies which accompany the shock.

In most applications it is possible to compromise on either one or the other type of mounting. For shipboard and mobile mounting the primary protection must be

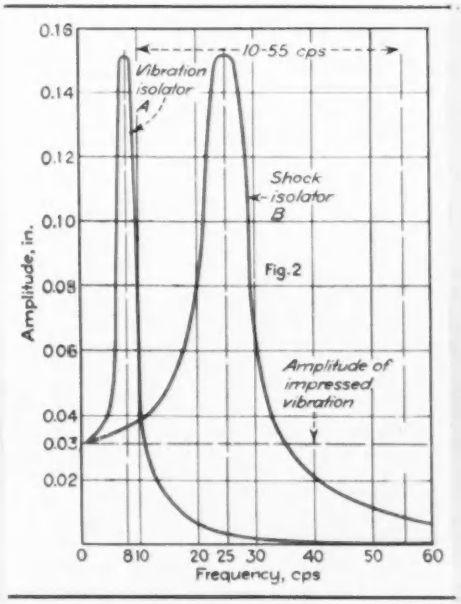


Fig. 2—Response curves for the two types of isolators. Isolator *A* can absorb vibrations down to 10 cps, while *B* can absorb shocks and vibrations down to 35 cycles per second.

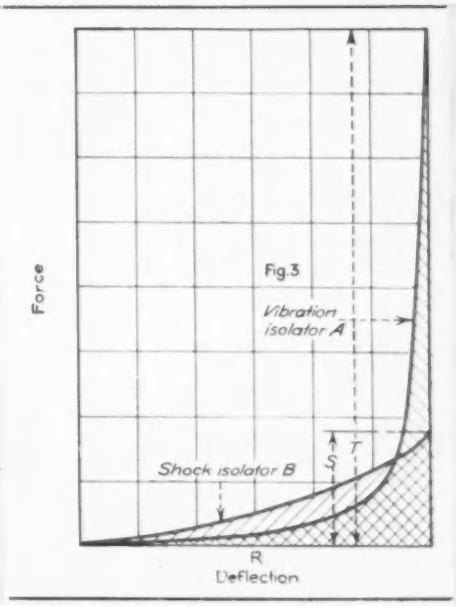


Fig. 3—Areas under curves represent stored impact energy. This is equal for both isolators, but maximum force for vibration isolator, *A*, is much greater than for shock isolator.

against high shocks since the damage caused by steady state vibration is of lesser importance. A 25 to 30 cycle mount has been suitable for such shock absorption applications. Furthermore, on board ship the most severe vibrations occur in the 5 to 23 cps range, with amplitudes up to 0.030 in. Resonances in this range should be avoided by designing the mounted system to have all natural frequencies above 25 cycles per second.

For airborne equipment, the problem has been the protection of equipment against fatigue failures caused by steady state vibration at frequencies in the 10 to 500 cps range. However, there has been no need to protect against shocks as high as those indicated for shipboard and mobile applications since the aircraft itself is not capable of withstanding shocks of such magnitude. The problem has been the isolation of steady state vibration with the isolators only being required to withstand shocks such as occur during a hard landing without attempting to absorb much, if any, of the energy of this type of shock.

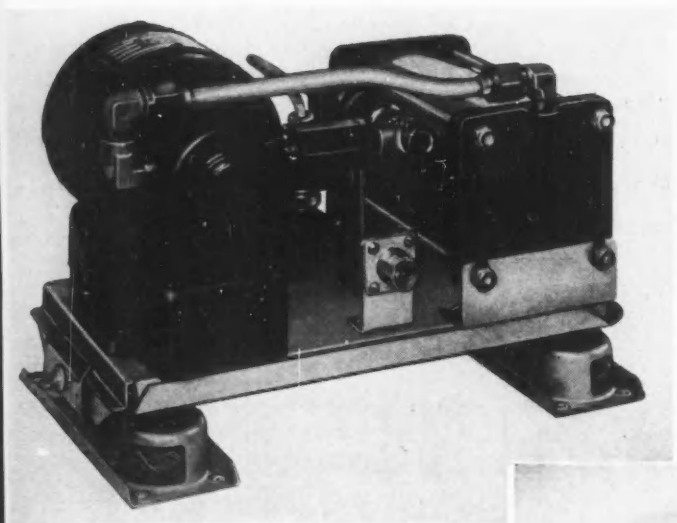
For jet and guided missile applications, the major frequencies to be isolated are in the order of 40 to 1,000 cycles per second. Because of the higher frequency range it is possible to use a shock isolator which gives good shock protection and also is capable of isolating these higher frequencies.

Under certain conditions, such as when sensitive instruments are mounted close to machine guns in aircraft, it is difficult to determine the proper type mount. The vibration caused by firing the guns can be of such high amplitude and of such frequencies that it may be necessary to make comparative tests under actual gunfire; testing soft mounts, stiff mounts, and no mounts at all, to determine which gives the best results.

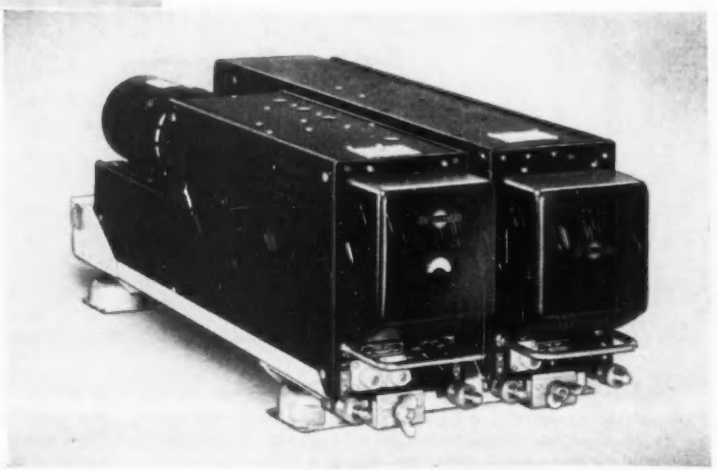
Thus, a soft mount or vibration isolator is not suitable to isolate shock such as encountered in naval and mobile applications. Likewise, a stiff mount designed to give good shock protection against high impact shock, and having a resonance of about 25 cycles, cannot isolate frequencies below 35 cycles per second.

In all applications, the mounted equipment should be given suitable tests to determine whether the mounts are satisfactory. These tests vary from fastening the equipment to an anvil and striking the anvil with a hammer, to testing mobile units in the back of a truck.

SHIPBOARD electronic equipment mounted on shock isolators. In this application, the units are given tests which simulate gun blasts, near misses and underwater explosions as encountered in wartime.



EXAMPLE of airborne equipment mounted on vibration isolators. This particular unit is a pressurizing kit manufactured by the Romec Division of Lear, Inc. Mounts are designed to isolate frequencies in the range from 10 to 500 cps.



AIRCRAFT TRANSMITTER and receiver package mounted on vibration isolators. In addition to steady state vibrations, aircraft electronic equipment must also withstand medium impact shock caused by landing.

ANOTHER METHOD: Converting Decimal Fractions Into Compound Gear Trains

HENRY C. GRAY
The Falk Corporation

In August 1952, page 158, Product Engineering presented an article describing a method for converting decimal fractions into gear trains. Mr. Gray suggests another approach when the designer has an automatic calculating machine and a table of numbers with their factors.

IN SELECTING GEAR TRAINS that require a high degree of accuracy, a designer can use an automatic calculating machine and a table of numbers with their factors to speed the process. One common application is the selection of lead change gears for hobbing helical gears. Here the degree of accuracy required varies from about ± 0.00010 for a 5 deg helix angle to ± 0.00001 for a 45 deg angle.

We can state the problem in equation form:

$$\frac{A}{B} \times \frac{C}{D} = a \qquad (1)$$

where A, B, C, and D are numbers of teeth in the four gears of the train, and a is the ratio required.

If we multiply the ratio by x/x, Eq (1) becomes:

$$\frac{A}{B} \times \frac{C}{D} = \frac{xa}{x} \qquad (2)$$

To select the proper gear train we must find an integer x which can be factored into numbers suitable for numbers of teeth B and D, and whose product with the ratio can be rounded off into an integer factorable into numbers of teeth A and C. The designer must also consider the gears available and the limitations imposed by the gear case.

To do this: lock the ratio a on the keyboard of the calculating machine and repeatedly touch the plus bar. The number of times this operation is performed appears on the counter dial and is possible value of x. The product of this number x and the ratio a appearing on the accumulator dial is a possible value of xa. The process is continued until a value of xa appears that can be rounded off to an integer. Then the numbers are checked for factors that meet the application requirements.

To demonstrate the method, find a train of gears with these specifications: an overall ratio of 0.547863; a tolerance of ± 0.00010, and A/B approximately equal to C/D, and from 100 to 125 teeth in each pair. In this example we assume that gears are available in all numbers from 20 to 100 inclusive, and if the total number of teeth in each pair falls within the range from 100 to 125, the gears will fit on the machine.

With the ratio, 0.547863, locked on the keyboard of the calculator, shift the carriage and run up values of x—1,000, 2,000, 3,000, etc. to find a suitable initial set of values (see table). Numbers of teeth in parenthesis are calculated mentally by taking the square roots of x for B x D and xa for A x C. Others are obtained from the tables of numbers.

The last, 3,000, of the approximations gives a sum of A and B (40 + 55) equal to 95. This is close enough to the desired 100 teeth to warrant using 3,000 as the starting value of x.

When x equals 3,002, xa rounds off to 1,645, introducing an error of 0.315 in 1,645 or + 0.00019. The last three decimal places of xa are dropped since they are not significant.

In choosing new values of x for acceptable values of xa, the values of x increase by differences that set a pattern. When established, this makes it possible to avoid the tedium and saves the time of increasing x by unity each time. Difference in this example run 9, 11, 9, 11, etc. Notice that the last four values of x represent possible solutions—close on tolerances and meeting other stipulations adequately.

One of the main advantages of this method is the fact that it can be applied equally well to ratios greater than unity without using the reciprocal and finally inverting the train.

x	B × D	xa	xa (app)	Error abs	Error 100.000	A × C	A × B	C × D
1.000	(32 × 32)	547.863000				(23 × 23)	55	05
2.000	(45 × 45)	1095.726000				(33 × 33)	78	78
3.000	(55 × 55)	1643.589000				(40 × 40)	95	95
3.000		1644.136863						
3.002	38 × 79	1644.684726	1645	0.315	19	35 × 47	73	126
3.003		1645.232589						
3.004		1645.780452						
3.005		1646.328315						
3.006		1646.876178						
3.007		1647.424041						
3.008		1647.971904						
3.009		1648.519767						
3.010	43 × 70	1649.067630	1649	0.069	4	17 × 97	60	67
3.019		1653.998	1654	0.002	0.1			
3.030	30 × 101	1660.025	1660	0.025	1.5	20 × 83	50	194
3.039		1664.956	1665	0.044	2.7	37 × 45		
3.050	50 × 61	1671.982	1672	0.018	1.1	38 × 44	88	105
3.061		1677.009	1677	0.009	0.5	39 × 43		
3.395	35 × 97	1859.995	1860	0.005	0.3	31 × 60	66	157
3.468	51 × 68	1899.989	1900	0.011	0.6	38 × 50	89	118
3.782	61 × 62	2072.018	2072	0.018	0.9	37 × 56	98	118
3.844	62 × 62	2105.985	2106	0.015	0.7	39 × 54	101	116
4.032	63 × 64	2208.984	2209	0.016	0.7	47 × 47	110	111

Hermetically Sealed Pump-Units Will Handle Any

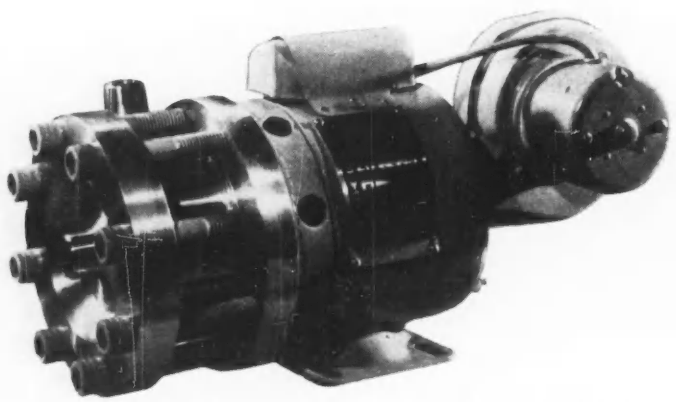


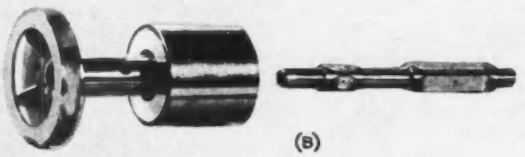
Fig. 1—General purpose type pump. Unit will handle fluids of varying density at temperatures up to 500 F. Motor stator is air cooled. Rotating elements are sealed in hermetically tight shell.

E. F. BRILL*
Chief Engineer, Atomic Power Section
Allis-Chalmers Mfg. Company

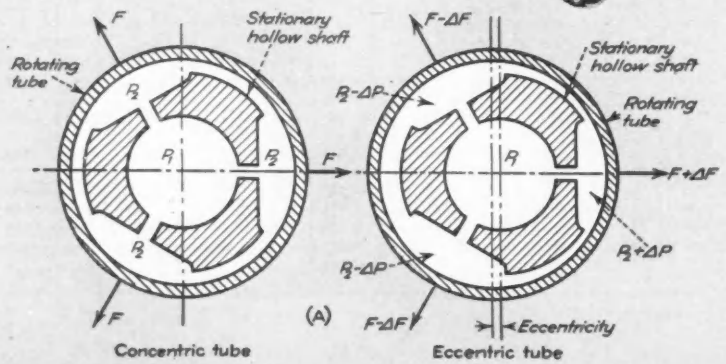
TWO NEW DESIGN CONCEPTS were required to make these units possible. The first is the fluid piston radial bearing. This consists of a tubular rotating shaft which is supported by fluid pressure so that it floats concentric with a stationary bearing shaft. The second concept is the canned motor principle where an induction motor rotor rotates in the fluid being pumped and is cooled by the same fluid. The motor stator windings are located outside of

* *The author thanks Hugh Ross, Chief Engineer, Centrifugal Pump Section, Allis-Chalmers Mfg. Co. for his help in developing this line of pumps.*

Fig. 2—(A) Schematic of fluid piston bearing. Equally spaced and equal magnitude radial forces tend to maintain tube concentric with hollow shaft. Actual shaft and rotor are shown in (B). This design uses four milled pockets.



(B)



P — Normal fluid supply pressure

P_2 — Normal bearing pocket pressure

F — Normal resultant forces exerted on inner surface of tube

ΔP — Variation in pressures because of eccentricity

ΔF — Variation in forces because of eccentricity

Motor Fluid

a nonmagnetic stainless steel shell which surrounds the rotor. With this construction, no packing seals are required and the rotating elements of the pump and motor can be included in one hermetically sealed shell.

These pumps are capable of pumping nonabrasive fluids with densities varying from that of gasoline to that of mercury. Temperature limits range from —100 F to 1,500 F and operating pressures up to 2,000 psi have been used. In Table I is shown a list of possible applications.

The rotating element of the pump consists of a tube on which the pump impeller and the motor rotor are mounted. This rotor is clad with corrosion resistant materials such as stainless steel, Inconel—X, Nichrome or Hastelloy. The impellers are made of similar materials or for extreme corrosive conditions they can be made of titanium, tantalum or zirconium. The tube rotates around a stationary center bearing shaft and incorporates an unusual bearing design.

Table I—Prospective Applications

Fluid Being Pumped	Remarks
1. Gasoline	Refineries, pipelines, bulk stations, trucks, dry cleaners solvent plants—to avoid leakage of explosive or inflammable vapors.
2. Alcohol	Distilleries, process plants, yeast plants.
3. Acids	Chemical plants, processes.
4. Special fuels	Rocket and jet fuels, torpedo fuels.
5. Highly volatile liquids	Propane, butane, liquified gasses.
6. Explosives	Nitroglycerine, molten explosives for shell loading, hydrogen peroxide.
7. Precious fluids	Heavy water, antibiotic slurries, drug concentrates, vitamin concentrates, perfume concentrates.
8. Poisonous fluids	Cyanide solutions, liquid chlorine, liquified poison gas, radioactive solutions and slurries, hazardous biological suspensions.
9. Liquid metals	Molten metals for heat transfer, mercury amalgam processing, die casting.
10. Boiler water	Recirculating under full system pressure.
11. Process fluids	Remote or inaccessible locations where frequent maintenance of seals and lubrication of bearings is undesirable.
12. Liquid food	Where contamination of fluid by lubricants or bearing materials is not permissible, and sanitation is imperative.

Fluid Piston Bearing

This type of bearing operates on the principle shown in Fig. 2. Three or more equally spaced bearing pockets are milled on a hollow shaft. An orifice hole connects each pocket with the center passage. If a close fitting tube is placed over this shaft and fluid under pressure is supplied to the shaft passage, the tube will float concentric with the shaft. Since the pressure is equal in all pockets, the radial forces on the tube are equal.

Any movement of the tube towards a pocket causes pressure to build up in this pocket because of the increased restriction of flow and reduced pressure drop across the orifice from the center passage to the pocket. The pressure in the opposite pocket simultaneously decreases. This produces a restoring force tending to center the rotating tube. The pump thrust bearing operates on a similar principle.

When starting this type of bearing from rest, there is a rubbing metallic contact for the first few revolutions until the fluid pressure builds up to the required value. While this rubbing would ruin film type bearings, it actually improves the appearance of the fluid piston bearing. During normal operation there is no change of clearance or wear in the bearings since there is no metal-to-metal contact.

Canned Motors

In the units shown in Figs. 3 and 4, the motor rotor is cooled by the fluid discharged from the bearings as it returns to the pump impeller. This fluid also removes the heat generated in the stator shell.

Hermetic sealing is obtained by welding this shell to the pump casing with the shell and casing containing all rotating elements. The stator shell must be constructed of a nonmagnetic material such as 300 series stainless or Inconel, so that the rotating flux properly couples the rotor. With the stator windings exterior to the sealed case, they can be replaced without exposing the fluid to loss or contamination.

These units are built with air cooled and water cooled stator windings for single-phase, two-phase, or three-phase power supplies. A separate motor driven blower is used for air cooling, while water cooling is accomplished by passing water through the interior of hollow copper stator conductors.

General Purpose Unit

These pumps are available in two general types: the general purpose unit and the multi-purpose unit.

The first type, Figs. 1(A) and 3, is used for pumping fluids at a temperature of 500 F or less. A fraction of the pumped fluid is taken from the volute of the main impeller to supply the bearings. Fluid enters the hollow stationary shaft at pump discharge pressure. With this arrangement, the heat removed from the rotor and stator shell goes into the main fluid system. Stator cooling is accomplished by forcing cooling air against the end turns and stator stack with a blower.

Either class A, B, or H motor insulation is available depending on ambient conditions. The pump rating while handling water at 2000 psi and 480 F is 20 gpm at a 60 ft head. The rating is varied when materials such as clean sodium potassium alloys or mercury are pumped. The multi-purpose type uses the same basic principles but has a wider range of application.

Multi-purpose Unit

This varies from the general purpose unit in that two impellers are mounted on the shaft, Figs. 1 (B) and 4. One is the main pump impeller while the other is the bearing supply impeller used to circulate fluid through the bearings and around the motor. Each has its own flow circuit and the two are separated by a heat barrier.

By using a separate impeller and circuit for bearing supply, the materials in the rotor space can be operated at a lower temperature than the primary fluid. Thus, while the fluid may reach a temperature of 1,500 F, the space surrounding the motor rotor is normally held below 1,000 F and only approaches this temperature when fused salts having a high melting point are being handled by the pump. When the rotor operates at high temperature, it runs at a speed lower than normal because of the increased rotor resistance. The separate bearing supply has the additional advantage of a constant bearing supply pressure that is independent of system conditions.

When water is used to cool the motor windings, the insulation temperature does not exceed 212 F. For high temperature service, with resultant high insulation temperature, silicone oils, glycols, Dowtherm, or other high temperature coolants are used.

For those applications where fluids handled by the pump may freeze when the unit is not operating, a 1,500 watt heater element is located in the center passage of the stationary shaft.

The operating life of these pumps depends to a great extent on the temperature of the fluid. At present more data are required before accurate predictions of life can be made.

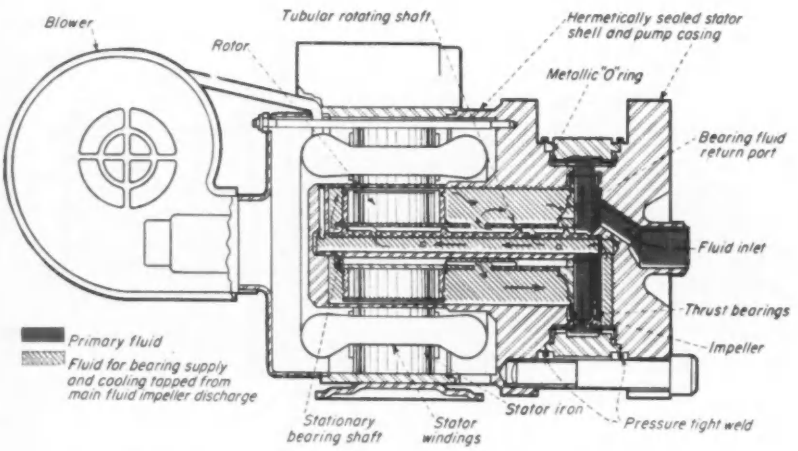


Fig. 3—Cross-section of general purpose unit. Shell is manufactured in three sections (stator shell, pump casing, and end bell) which are welded to be pressure tight. Inlet and discharge connections are designed for butt welding.

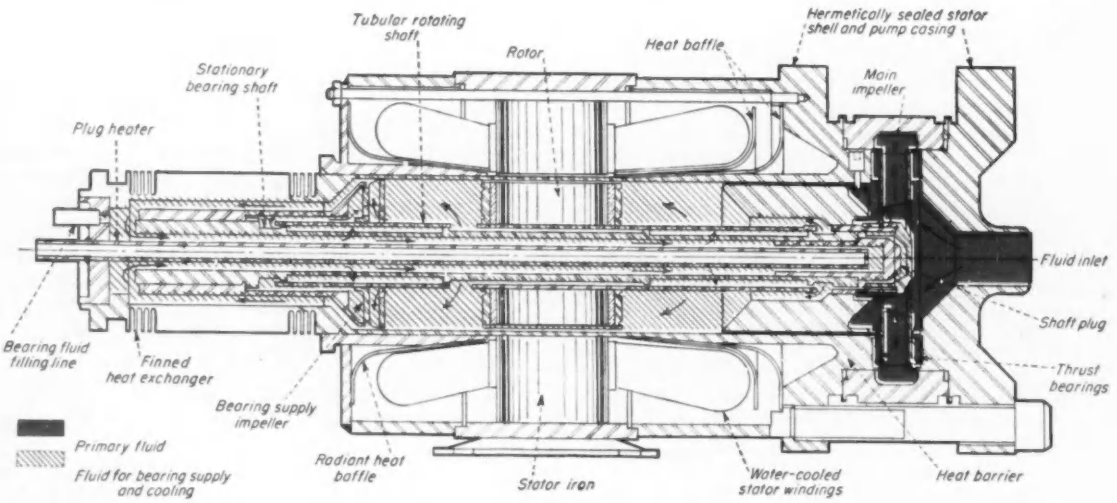


Fig. 4—Multi-purpose pump with two impellers and air cooled bearing supply. Motor stator laminations fit tightly over stator shell. The thin shell can withstand internal pressures exceeding 2,000 psi with support of laminations and end rings.

DEPRECIATION

And Its Crucial Economic Role

The sixth annual McGraw-Hill survey of Business' Plans for New Plants and Equipment, just completed, reveals some remarkable facts about the role of depreciation in our economy. To most people, depreciation is a technical term, used by accountants to discuss a dull subject. But it really is a simple matter: It is the amount of money set aside each year by a company to replace plant and equipment that is wearing out. And here are some facts from this survey* which show how depreciation can make the difference between prosperity and recession in the United States:

1. *In 1953, about half of all the money spent on new manufacturing plants and equipment will come from depreciation reserves.* For the future, manufacturing companies are relying even more heavily on this source of money. In the years 1954-56, they count on using their depreciation funds to pay for almost two-thirds of the new plants and equipment now planned.

2. *The amounts of money made available by depreciation allowances vary greatly from industry to industry.* Some industries, such as those producing steel, chemicals and petroleum products, will have relatively large amounts of cash available from their depreciation reserves. In considerable measure, this is because the government is allowing them to accumulate such reserves at an accelerated rate as an encouragement to build facilities required for national defense. But most of the companies engaged in the production of textiles, processed foods and many kinds of machinery have had little chance to benefit by this provision for accelerated depreciation. Hence, they have much less money available from depreciation reserves.

3. *There is a definite shortage of investment funds in the industries that have relatively low depreciation allowances.* Taken together, the coal mining, textile, food processing, machinery and other metal-fabricating industries plan to spend about $4.7 billion for new plant and equipment this year. But they report that they would spend $1.5 billion *more* per year during the period 1954-56 if sufficient funds were available.

4. *Eighty-five per cent of the manufacturing companies covered by the survey reported that they plan to invest all their depreciation funds* to keep equipment up-to-date and to provide capacity for new products and new markets. These companies could let their depreciation funds pile up as idle cash. But the intention is to spend most of them for capital equipment.

*The sixth annual McGraw-Hill survey of Business' Plans for New Plants and Equipment included companies that provide 25 per cent of all industrial employment and 60 per cent of employment in those industries where capital investment is highest. These companies are mostly the larger companies in their respective industries. A copy of the full report of this survey can be obtained by addressing: Department of Economics, McGraw-Hill Publishing Company, Inc., 330 West 42nd St., New York 36, N. Y.

Hence, there is a direct relationship between the amount of depreciation funds available and the level of capital investment. And it is upon the latter that the level of general prosperity decisively depends. One-third of all industrial workers are engaged in producing or installing such equipment.

This fact that the level of depreciation allowances has a major bearing on the level of capital investment should not surprise anyone. In several foreign countries where these allowances have been increased, investment has boomed. The two nations with the highest ratios of investment to national income are Canada and Norway. Both countries adopted flexible depreciation policies after World War II. In Sweden and The Netherlands also, flexible depreciation allowances have contributed to rapid industrial expansion. Finally, the tremendous investment brought about by our own rapid amortization program shows dramatically the importance of depreciation in stimulating capital expenditures.

Obsolete Tax Laws

In spite of this record, the fact remains that our laws and the business procedures that govern depreciation allowances—in particular the laws and rulings that govern the deduction of depreciation from taxable corporate income—are still based on antique and obsolete accounting concepts which take no account of depreciation's dynamic role in our economy. The internal revenue code still requires most companies to depreciate their equipment over a long period, even though these small annual allowances cannot possibly pay for the investment that is necessary to keep a plant up-to-date under today's rapidly changing technology, with its production of new and improved machinery.

The only allowance made by the government for rapid depreciation is that which is authorized for certain types of plants during the defense emergency. Under this policy most companies are unable to use accelerated depreciation for tax purposes. And as defense projects are completed, the number of new authorizations is dropping. We may lose the chance to utilize fully this powerful tool for sustaining investment because, under our ramshackle emergency tax structure, accelerated depreciation is available only to a minority of firms on a temporary basis.

New Policy Needed

A sensible, up-to-date depreciation policy for tax purposes is long overdue. Either the Treasury must modernize the internal revenue code on its own initiative, or Congress must take the lead by writing into permanent law a flexible depreciation policy applicable to all companies.

Treasury experts now have before them a number of proposals to allow faster depreciation for the average firm. The U.S. Chamber of Commerce has suggested that companies be allowed to deduct from taxable income 25 per cent of the cost of new equipment in the first year, with the remaining cost to be deductible over the life of the facilities. The Machinery and Allied Products Institute has long sponsored a formula that would allow full deduction in two-thirds of the estimated life of the property. In Congress, Chairman Reed of the Joint Committee on Internal Revenue Taxation has stated that we need a more flexible depreciation policy. Senator Frear of Delaware has introduced a bill that would let a business make its own choice on how fast to depreciate its equipment.

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SPECIFICATION AND COLOR CODING OF ELECTRICAL WIRE

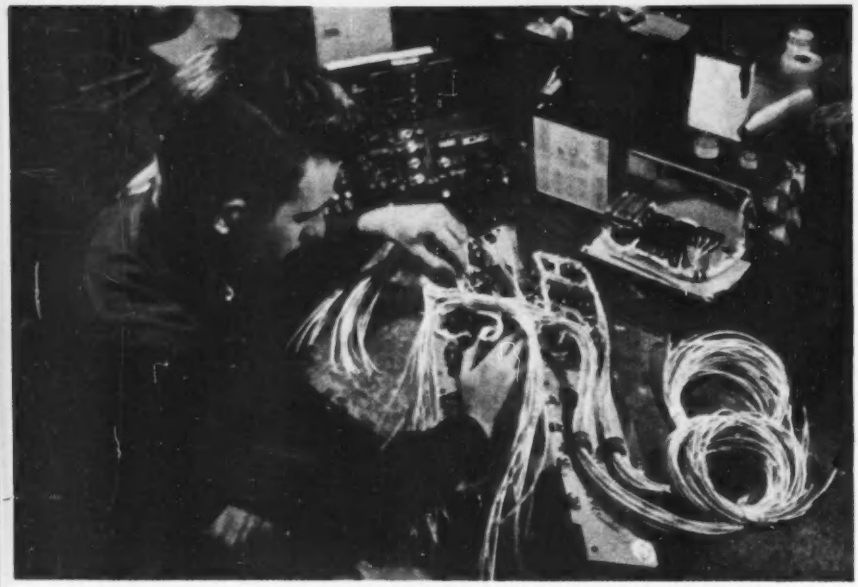
JAMES A. PETTIT, Jr.
Plastoid Corporation

With the development of electrical and electronic circuits for drives and controls on present day equipment, electrical circuitry has become complex to the point where it is not unusual to find five miles or more of wiring in a modern military fighter plane or several thousand feet in the sequencing circuits of a machine tool. Malfunctioning of these may not only cause spoilage and loss of production, but, in the case of military gear, loss of life and equipment. Thus, proper selection of the wiring becomes as important as specification of the drives and controls.

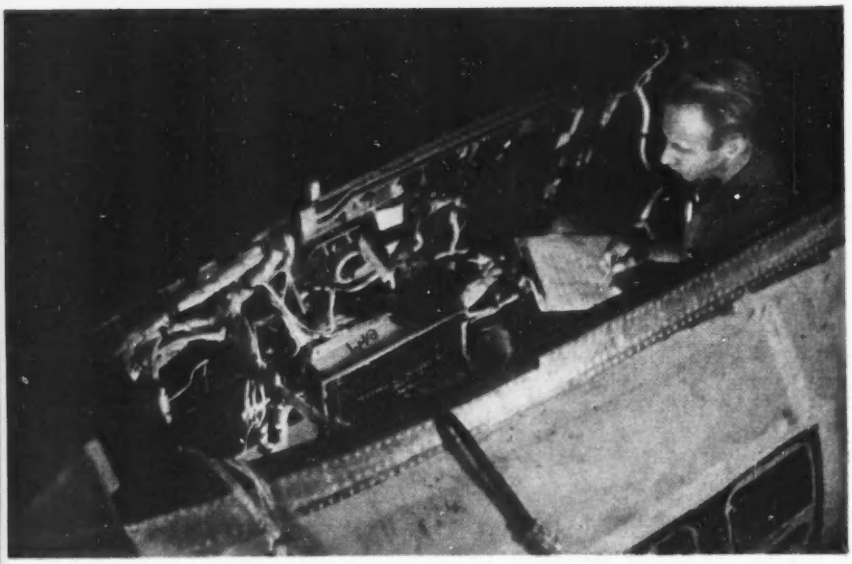
In addition, circuit identification by color coding is a major consideration in design. Proper circuit identification permits substantial production savings because of faster hook-up on assembly lines, faster testing on the inspection bench, and simplified trouble shooting on defective units. Furthermore, these features are equally important in checking through a complicated circuit during preventative or repair maintanence operations in the field, and consequently they also provide an added assurance of customer acceptance of, and satisfaction with, a given product.

Properties Governing Choice of Insulated Wire

The choice of an insulated wire to be specified in a given application is based on the characteristics of the material and its relative price position in comparison with other materials, as well as on the ease with which it may be incorporated in the manufacturing operation. In general, the



Wiring for the main pilot control panel in Republic's F-84 Thunderjet. Printed codes on the insulation permit tracing of connections. Recently, interest has focussed on color coding of thermosetting and thermoplastic insulation.



An idea of the wiring complexity in a modern military fighter plane is indicated by this cockpit view of the Thunderjet. For the most part, numbered codes on insulation or tagged ends are used in this application.

Color coding of power and control wiring is common practice in the machine tool industry as illustrated by this control for the Sundstrand Rigid-mil.

properties governing selection are as follows:

Dielectric strength is a direct measure of insulation thickness required for a given voltage. However, it is not the complete answer. Such factors as limitations in extrusion technique, variations in raw materials, and specification of stranded conductors influence the minimum wall thickness that may be supplied on a given wire. Furthermore, a consideration of the mechanical abuse to which the material will be subjected influences the wall thickness finally decided upon.

Insulation resistance, which may be measured in terms of volume resistivity, also should be considered in any application. It provides an index of relative energy drain placed on a circuit by the wiring. This lost energy may merely represent a power loss or it may result in undesirable energy transfer between otherwise separate circuits.

Surface resistivity is a measure of energy loss along the surface of an insulation. There is no direct relation between the insulation resistance of a material and the surface resistivity. Therefore, each of these characteristics must be considered separately.

Ozone resistance is important if the electrical field established in the region surrounding an insulated wire is intense either because of the physical configuration and/or because of the high voltage of the circuit. The air in proximity with such circuits may ionize and the resulting ozone has a deleterious effect on many insulating materials.

Water resistance is a measure of the ability of material to resist liquid penetration; and resistance to high humidity is a measure of the material to resist water vapor penetration.

Impact resistance, crushing resistance, abrasion resistance and flammability are all a measure of the material to withstand mechanical abuse. **Flexibility** describes the resultant insulated wire and is a measure of the relative ease with which the wire may be bent. It does not indicate the number of

flexural strains which the insulation may withstand.

Temperature range may be set for a number of different reasons. The estimated life cycle of thermosetting materials is a prime consideration when establishing the upper operating temperature. Experience has shown that rapid change in performance occurs at elevated temperatures. Furthermore, both electrical and physical characteristics are adversely affected.

Usually thermoplastics are restricted in safe upper operating temperature by physical changes which occur at these temperatures. High temperatures drive off the plasticizers and the insulation becomes quite brittle. Moreover, "cold-flow" becomes high and the insulation values may be reduced below a safe value if the temperature exceeds recommended values.

The above properties should be considered for any electrical wiring, whether it be for direct current, alternating current at low frequencies, or alternating current at high frequencies. Those which remain to be discussed are significant only at high frequencies—400 cycles and above.

Power factor is a measure of the energy loss and hence attenuation. In a given installation the greater the power factor of the insulating material, the higher will be the attenuation or loss in signal strength.

Finally, dielectric constant is of importance when it is necessary to consider the capacitance of the wire. The capacitive effect resulting from the introduction of an insulated wire in a circuit will vary directly as the dielectric constant. Both the power factor and dielectric constant may vary with frequency and/or temperature; and, hence, an improperly selected dielectric material may introduce instability into a circuit.

Average values for these and other properties of the common classes of insulating materials are given in the table on the following pages. Within any of these classes, the formulation can be varied to obtain a range of properties, so that the values are for mean rather than specific performance. In addition, of course, the figures represent properties before any outside covering is added; in many cases, such as wire having rubber insulation, an outside braid improves performance.

Types of Insulated Wire

In general, the materials used in the manufacture of insulated wire may be divided into two classes, thermosetting and thermoplastic materials. The thermosetting materials are those which are applied when they are in a plastic state and which, after proper curing, undergo a chemical change so that they may not be reduced again to their original plastic state merely with the application of heat. Natural - rubber, synthetic - rubber (such as GR-S and Butyl), silicone-rubber, Neoprene and Teflon are thermosetting.

Thermoplastic materials are usually heated prior to extrusion and are subsequently cooled below the point at which plastic flow is encountered. If the temperature of the thermoplastic material is increased sufficiently, it will once again become plastic. Polyvinyl chloride, polyethylene, Nylon, monochlorotrifluoroethylene (fluorothene or Kel-F), and ethyl cellulose are all thermoplastic types of materials.

Code grade rubber, 'the workhorse' of the rubber clan has proved itself in a large number of applications as an inexpensive, durable electric-insulation. Since it is limited to direct-current and alternating current of power frequencies, power factor and dielectric constant are not important. Wire employing this insulation will have good insulation resistance and dielectric strength. It is not satisfactory in circuits where there is a possibility of corona phenomenon. Furthermore, it has poor surface resistivity, and poor resistance to mechanical abuse. In addition, the copper conductor of a wire insulated with code-grade rubber must be protected either by a layer of tin, cotton or paper to prevent interaction of the sulfur in the rubber with the copper.

It should not be used where it will be exposed to water, high humidity, sunlight, acids, alkalies, or petroleum oil. It exhibits no tendency to cold flow. Its normal operation is between 60 and —40 C. However, the addition of an impregnated braid improves its resistance to heat, also mechanical abuse, and atmospheric deterioration.

The performance of the water-resistant rubber compound is similar to that of code grade rubber with the following exceptions. The power factor is much lower and hence it is suitable for use at frequencies up to 10,000 cycles. Due to special compounding it may be exposed to water or high humidity. In all other respects its performance is identical.

Heat resistance rubber may be operated safely from —40 to 75 C. This extended operating range is the only advantage over code-grade performance.

To obtain a rubber compound which would perform satisfactorily when exposed to an atmosphere of ozone, still another special group of formulations were developed. In addition to improved resistance to ozone, these materials were found to give fair performance when exposed to water and good results when exposed to high humidity. Furthermore, the operating temperature of this material extends from —40 to 70 Centigrade.

It should be re-emphasized that these four broad rubber classifications represent a norm, and wide variations in properties can be obtained by proper formulation. Special performance with regard to a particular property may be realized at the sacrifice of one or more of the other properties.

Although Neoprene is a thermosetting material, it is chemically quite different from the rubber compounds. Originally, it was employed in place of rubber compounds as a jacket stock because of its resistance to impact, abrasion, flammability, oil, sunlight, and water. Subsequently it has found special application as an insulation.

In addition to the features just mentioned, it exhibits good ozone resistance, fair tolerance to a number of acids and alkalies, and has a normal temperature range of from —50 to 60 C. However, since an undesirable reaction takes place between neoprene and copper, it is necessary to use a separator over the copper conductor similar to that used for rubber compounds.

The last of the thermosetting materials to be discussed is silicone rubber, which derives the name rubber primarily from its characteristics rather than from a similarity of chemical structure. A first glance would seem to indicate that it is the most outstanding of these materials in performance. It has a low power factor and hence is suitable for use in circuits up to one megacycle. It is equal to the rubber compounds in dielectric strength and insulation resistance. It has ex-

PROPERTIES	TYPES OF			
	CODE GRADE	WATER RESISTANT	HEAT RESISTANT	OZONE RESISTANT
Power factor	6	1	4	5
Dielectric constant	6	3	5	5
Dielectric strength (V/mil)	300	300	300	400
Insulation resistance	Good	Good	Good	Good
Operating frequency	Power	10,000	Power	Power
Surface resistivity	Poor	Fair	Poor	Poor
Operating temperature, C				
Maximum	60	60	75	70
Minimum	−40	−40	−40	−40
Specific gravity	1.42	1.20	1.70	1.40
Ozone resistance	Poor	Poor	Poor	Very good
Resistance to weak acids				
Organic	Poor	Poor	Poor	Fair
Inorganic	Fair	Fair	Fair	Fair
Resistance to strong acids				
Organic	Poor	Poor	Poor	Poor
Inorganic	Poor	Fair	Fair	Poor
Resistance to alkalies				
Weak	Poor	Fair	Fair	Poor
Strong	Poor	Poor	Poor	Poor
Resistance to petroleum oil	Poor	Poor	Poor	Poor
Water resistance	Poor	Very good	Poor	Fair
Resistance to humidity	Poor	Very good	Poor	Good
Weather resistance	Poor	Poor	Poor	Good
Flammability	Slow burning	Slow burning	Slow burning	Slow burning
Impact resistance	Fair	Fair	Fair	Fair
Abrasion resistance	Fair	Fair	Fair	Fair
Crushing resistance	Fair	Fair	Fair	Fair
Flexibility	Very good	Very good	Very good	Very good
Resistance to cold flow	Very good	Very good	Very good	Very good

ELECTRICAL INSULATING MATERIALS

NEOPRENE	SILICONE RUBBER	POLYVINYL CHLORIDE	POLYETHYLENE	NYLON	FLUOROTHENE	TEFLON
3.5	0.2	10	0.02	4.5	——	0.03
7.7	5	6.5	2.3	0.45	——	2.1
300	300	300	500	450	——	500
Fair	Very good	Good	Excellent	Very good	Excellent	Excellent
Power	To one megacycle	Power	Entire range	To one megacycle	Entire range	Entire range
Fair	Very good	Very good	Very good	Very good	Excellent	Excellent
60 −50	150 −55	80 −40	85 −70	150 −50	150 −125	300 −125
——	——	1.3	0.9	1.1	——	2.2
Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Good Excellent	—— Good	Good Excellent	Excellent Excellent	Good Good	Excellent Excellent	Excellent Excellent
—— Fair	—— Good	Poor Excellent	Excellent Good	Good Poor	Excellent Excellent	Excellent Excellent
Good Fair	Good Fair	—— ——	Excellent Excellent	Good Good	Excellent Excellent	Excellent Excellent
Good	Good	Good	Fair	Good	Excellent	Excellent
Good	Very good	Very good	Very good	Very good	Excellent	Excellent
Good	Very good	Very good	Very good	Very good	Excellent	Excellent
Good	Good	Very good	Very good	Very good	Excellent	Excellent
Not combustible	Not combustible	Not combustible	Slow burning	Not combustible	Not combustible	Not combustible
Very good	Poor	Very good	Very good	Excellent	Very good	Very good
Very good	Fair	Very good	Excellent	Excellent	Excellent	Excellent
Very good	Poor	Good	Very good	Excellent	Excellent	Excellent
Good	Fair	Good	Good	Fair	Fair	Fair
Very good	Good	Good	Good	Good	Good	Good

cellent resistance to corona; it may be exposed to sunlight, water and high humidity in all normal applications; it has high surface resistivity and exhibits a greater tolerance to acids, alkalies and petroleum oil than the rubber compounds; and it does not support combustion. However, its weakness lies in its inability to withstand rough handling; it has poor resistance to crushing and impact and only fair resistance to abrasion. This poor performance may be improved in some measure by the addition of an impregnated braid.

Here is color coding of both braided and unbraided electrical wiring. Besides solid colors, the insulation may be striped with from one to several colors, or may be coded by a unusual physical configuration of the stripe. However, the type of insulation governs to some extent the coding that can be employed (see text).

Standards established by the Armed Services for the basic colors on electrical wiring. The National Electrical Manufacturer's Association also has standards for thermoplastic insulated wire. To extend the range, striping can be used, as noted previously.

The feature always associated with silicones is outstanding resistance to operating temperatures, and silicone rubber insulation is no exception. It may be operated as low as −55 and as high as 150 C. This is an important performance characteristic, particularly when the current emphasis on circuit miniaturization and resultant higher operating temperatures are considered.

All of the thermosetting materials lend themselves to the same type of color coding. It is possible to include pigments in the compound and obtain a wide variety of solid colors. However, since a large portion of rubber insulated wire is supplied with a braid, the coding is included in the braid or in a paint applied over the braid. It has been indicated that a protective covering must be placed over the copper conductor. This eliminates the use of tinned conductors for coding but it does not prevent the use of colored conductors. In many applications, the separator, paper or fiber wrap, is colored and used for circuit identification. Spiral striping has not been used extensively for coding rubber insulations.

In recent years, thermoplastic materials such as polyvinyl chloride, polyethylene, fluorothene (Kel-F) and Teflon have supplanted rubber compounds in many applications. In many instances, the wire consists only of the copper conductor and a covering of thermoplastic material. The excellent insulation resistance and dielectric strength of thermoplastics, as well as their good resistance to mechanical abuse, make such construction possible. And while the fact that these materials pass into the plastic state at high temperatures may pose a problem in installation, their general acceptance indicates that with proper technique this offers no insurmountable difficulty.

Polyvinyl chloride compounds have a dielectric strength and insulation resistance of the same order of magnitude as the rubber compounds. They have inherently, excellent corona resistance and surface resistivity. They may be used where exposed to oil, water, and high humidity. They show superior performance where exposed to most acids. They do not support combustion and possess good resistance to impact, abrasion and crushing without any additional covering. When operating within their recommended range of temperature from −40 to 80 C no harmful cold flow will be experienced.

Special formulations are available which are satisfactory for operation over the temperature range from −40 to 105 C. In a similar manner formulations have been prepared for jacket stocks which are tough, abrasive, oil and water resistant. They are inferior to rubber only in that wire insulated with polyvinyl chloride will be slightly less flexible.

It is possible to employ all methods of coding on polyvinyl chloride insulated wire. Body color may be changed by the inclusion of a suitable pigment in the formulation, or spiral striping may be added to the body color to extend the color combinations desired. If, because of conditions existing in a special application, it is desirable to add a braid, the braid may be coded.

While polyvinyl chloride is an excellent all around insulation, it has one serious limitation: it is limited to low frequency application. It is for this reason that polyethylene has found wide spread use as an insulating material.

Polyethylene has very good electrical properties. It has a low power factor and dielectric constant, is stable over the entire frequency spectrum and also over the range of operating temperatures, has high dielectric strength and unusually high insulation resistance, is resistant to water penetration and to the acting of acids, alkalies and some oils, and has negligible cold flow when operated under 85 Centigrade.

This temperature limitation on polyethylene is the key to its use. When heated to slightly above 100 C it immediately changes from a solid to an almost liquid state. This means that polyethylene cannot tolerate even momentarily a temperature in the range of 105 C or conductor displacement will occur and the conductor may be completely bared. The temperature of 85 C is specified to give a margin of safety.

Polyethylene compounds are ordinarily used where exposed to high humidity and where high surface resistivity is desirable. They have good resistance to ozone and may be compounded to withstand exposure to sunlight. In fact, in addition to serving as an insulation one compound is employed by the Western Electric Company as a jacketing material in the Alpeth cable. In this application it serves in conjunction with other construction features as a substitute for a lead sheath.

Polyethylene may be colored by the introduction of pigment of almost any color; or conductor color coding may be employed. Spiral striping inks have been developed which are compatible with polyethylene and which give a clear distinct

and permanent stripe. Finally braids may be employed over the polyethylene into which desired coding may be incorporated.

Nylon is the third thermoplastic which is used extensively in the wire industry. Although it is considered as an insulation its greatest use is as a jacket over the other thermoplastics. It has excellent resistance to oils, acids, alkalies, and water. Its resistance to mechanical abuse such as abrasion, impact and crushing is superior.

When Nylon is considered as an insulation it has very good electrical properties. Its dielectric strength and insulation resistance are high; and the low power factor and dielectric constant make it suitable for use at high frequencies. However, it is not as satisfactory as polyethylene since it does not possess the same stable dielectric constant and power factor. Of the thermoplastics considered it has the widest operating range which extends from −50 to 150C.

Nylon insulated or jacketed wire may be coded either by coding the copper conductor or, when the nylon serves as a jacket, the insulation may be colored or striped to show through the transparent Nylon covering. In other cases the Nylon jacket is striped.

Recently two new thermoplastic compounds have been introduced as potential wire insulations. Monochlorotrifluorethylene has been offered under the trade names of Kel-F and Fluorothene. It is remarkably inert and is judged to have excellent resistance to acids, alkalies and petroleum oil. It may be used where exposed to water and sunlight or to high relative humidity. It has good electrical properties and may be used over a wide range of temperatures. It has excellent resistance to ozone. When the possibility of mechanical injury is considered, Fluorothene has much to recommend it. It will withstand a considerable impact, abrasion or crushing. It may be supplied in a wide variety of colors by the addition of pigment. Braids may be added for the purpose of circuit identification. However, since this material is used at temperatures up to 150C, a glass braid should be specified. Spiral striping has not been developed for this insulation.

Finally and appropriately, Teflon seems to offer the potential wire consumer everything but economy. This too like Fluorothene is chemically inert. In fact there is a great similarity between Teflon and Fluorothene in chemical structure. It will not react with acids, alkalies or oil. It may be used in locations where exposed to water or high relative humidity. It too offers excellent resistance to mechanical abuse such as abrasion, crushing or impact. It is non-flammable and can withstand exposure to sunlight.

Teflon has an operating temperature from below −125 to over 300C. Furthermore it has excellent electrical properties. It has high dielectric strength, insulation resistance and a low power factor which is stable over a wide range of temperatures. It resists the destructive action of ozone. Its chemical inertness makes it difficult to find a material with which to stripe the wire, and hence coding is accomplished either by the addition of a glass braid or a peculiar physical configuration.

Coding of Thermoplastic-Insulated Wire

For purposes of standardization, the electrical industry, through the National Electrical Manufacturer's Association has established standards for the basic color to be used on thermoplastic-insulated wire. Furthermore, the Armed Services have also established a set of standards for the basic colors to be used in supplying the Military. These standards permit a range of colors within which a given color must lie. (See Fig. 5).

However, only eleven basic colors are available: white, black, red, green, yellow, blue, tan, brown, gray, purple, and pink. To extend the range of coding, striping is used. In the striping machine, as the wire is fed through the revolving head supporting the striping wheels and ink reservoirs, a small amount of ink is transferred from the reservoir to the wire surface by means of the striping wheel. So that the coding may be properly interpreted the first colored stripe is made wider than the remaining stripes. The maximum possible number of available codings is over 6,000. It is readily apparent that coding is not a limiting factor in circuit specification. However, in general, in order to expedite deliveries it is desirable to employ a natural colored compound with any combination of stripes.

It is apparent that the insulated wire industry has made available the means whereby a system of standardized coding may be established which is similar to that currently employed and universally accepted in coding resistors and condensers. However, there is one main difference in the purpose of coding wire: the coding on the wire will be employed primarily to identify the circuit and not the component. It is true that the radio industry has standardized on a very simple coding for identifying the main circuits in electronic equipment, but it is also true that no standardized system of coding is accepted today which fully exploits the possibilities offered by spiral-striping. It should be re-emphasized that spiral striping offers a permanent, inexpensive and readily distinguishable method of coding. And with a carefully established and universally accepted system, even the most complex circuits could be easily read through the information supplied by properly color-coded wiring. Furthermore, although only three stripes are available at the present time, more could be added if necessary.

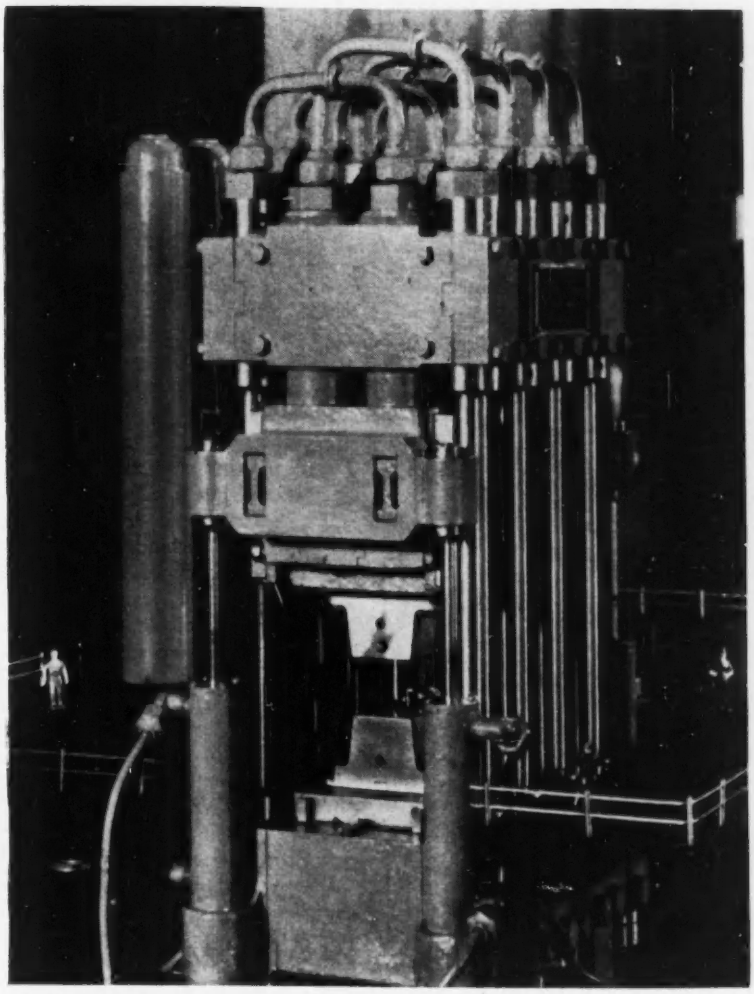
In order that the resulting striped wire will suffer no delecterious effects a careful selection of striping ink must be made. It is possible to stripe polyvinyl chloride, polyethylene and nylon thermoplastics at this time. In a combination construction, i.e., polyvinyl chloride or polyethylene insulation with a Nylon jacket it is customary to stripe the insulation since the striping may be readily viewed through the transparent vinyl or Nylon covering.

Coding through color may also be accomplished by coloring the metallic conductor. This is quite effective when translucent, polyvinyl chloride, polyethylene or Nylon insulations are employed.

In addition to coding through color, other methods have been employed. The conductor may be tinned or untinned, or it may be stamped with letters or numbers. This latter method is not very satisfactory since ready identification is impossible at points along the wire.

At times the physical configuration of the wire may be used. A ridge or series of ridges on the insulation throughout its length may identify a wire or in parallel constructions one ridge may be sufficient for one, two, three or more conductors.

Numbers or letters printed at regular short intervals on the surface of the wire permits an unlimited number of codes. This latter system, however, is not one subject to general interpretation at this time.



SCALE MODEL of the 35,000 ton forging press, being built for Harvey Machine Co., Inc. of Torrance, California by the United Engineering and Foundry Company of Pittsburgh, Pa. The press will tower 70 ft above the operating floor and its foundation will extend 45 ft into the ground. Maximum dimensions of die blocks are 12 x 24 feet. The Air Force program includes 8 such presses with capacities up to 50,000 tons.

HEAVY PRESS FACTS

NOW THAT MOST OF THE DETAILS of the heavy press program have been made public, the Air Force is under heavy industry fire in some quarters on the basis of the high costs that are involved.

In the heavy press program, the Air Force is advancing funds for the construction of seventeen large forging and extrusion presses, and the buildings to house them. The facilities will be leased and operated by private contractors. The pressed parts will replace structural members which are now built by assembling individual pieces. The resulting savings in cost, manpower, and in time will, the Air Force believes, be enormous.

Some industry observers who aren't so sure, base their objections on three points that will be unknown factors until the presses are in operation: (1) how many assemblies can be replaced by a single forging or extrusion; (2) the actual savings that will accrue, which, of course, depend not only on the specific parts involved but also on future production requirements for planes; and (3) the effect of mass on the design of the forging or extrusion.

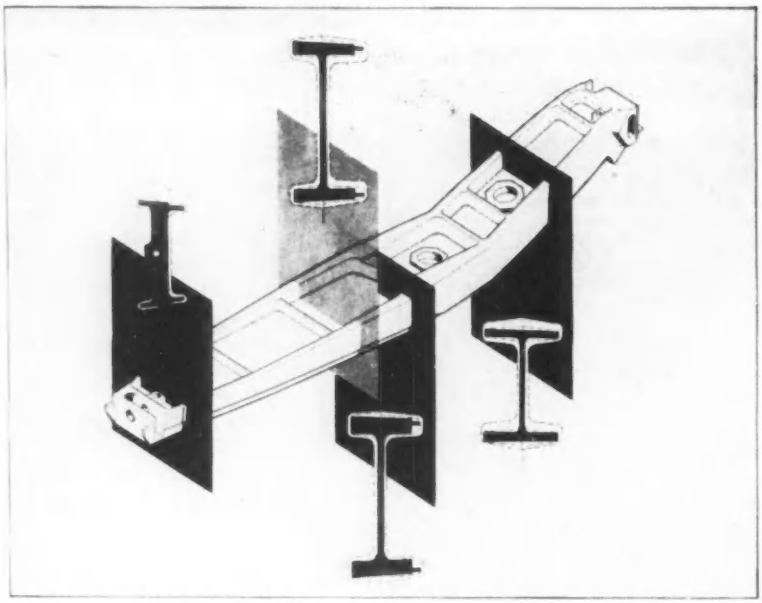
But in view of the contracts between the Air Force and the press operators, the program looks like a good gamble. The contracts provide that:

- The Government pays no subsidy to plant operators.
- Each operator will pay to the Government a fixed percentage of the total dollar volume of business done by the heavy press facility, regardless of whether the operator himself makes a profit.
- Certain engineering research and development costs will be paid by the operator.
- The operator will pay all of the costs of operation and maintenance.
- The Government does not guarantee to the operator a market for his products.

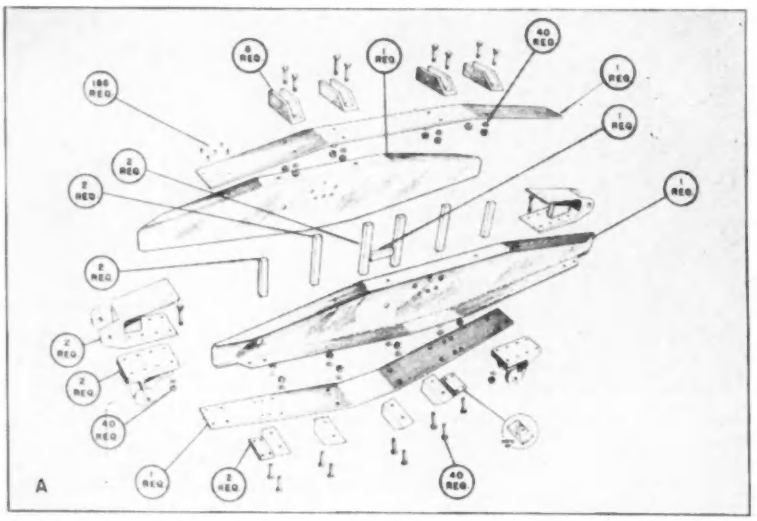
Continued production of planes at the present rate of 1,000 planes a month will, the Air Force estimates, result in press plants being paid for in not more than five years. A mobilization comparable to World War II would result in liquidation of the press projects in less than one year. As insurance for the investment in the event of cut-back in procurement of military planes, the heavy presses can be turned to the production of components for commercial and civilian aircraft. This is a strong and expanding market, which would yield a dollar volume of business which would assure retirement of the Federal investment in reasonable time. Meanwhile, many years may pass before the operator has recovered his initial investment in engineering and development costs, and he begins to make a profit. This is a new pattern for military procurement contracts. It is one which is especially advantageous to the Government, and could well be followed in other procurement programs.

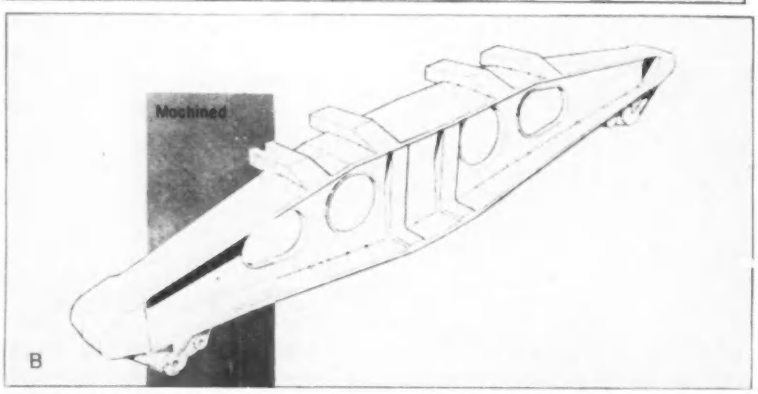
Cost Savings Summarized

Heavy press operators and aircraft engineers have gathered around conference tables to determine where press produced parts shall be used, and to



WING BEAM in a new jet fighter, now being produced by hammer forging, weighs 259 lb in rough form, press forging will weigh 155 lb, and 132 lb finished.





BOMBING SYSTEM beam as currently produced (A) and as designed for press forging (B). Cost differential favoring the forging is estimated to be $146.

estimate the savings that will result. It is obvious that savings will vary with size and design of the aircraft. For one heavy fighter plane that savings may reach fifty thousand dollars per plane. At this rate, press products for one thousand of these planes will result in a savings of fifty million dollars which will pay for one entire heavy press plant, equipped with two large forging presses, two extrusion presses, and all supporting facilities.

Savings of this magnitude are based on reductions in material, labor, and machining time. Savings in costs of material will result from at least three factors:

1. Many present day aircraft parts are machined from rough hammer forgings, or from rolled plate. Heavy presses will provide parts that are much closer to the desired finished section. Less machining will be required; less scrap will be produced. Savings will result from the fact that alloys which may cost fifty cents per lb or more will be conserved for use in manufacture of the plane rather than being converted to scrap that is worth perhaps around nine cents per pound.

2. Elimination of bolts and rivets, and of overlapping metal at mating joints.

3. Extruded sections have mechanical strength superior to that of machined plate. For example, the yield strength of 75S-T6 alloy extruded shapes is 9.1 percent greater than that of machined plate in thickness from $\frac{1}{4}$ in. to 2 inches. By designing to these greater strengths, savings can be accomplished through use of lighter sections.

The cost of labor for the assembly in present day "bits and pieces" construction of aircraft is an extremely important factor in the cost of finished planes. The advent of one-piece forged and extruded sections will eliminate a large part of this cost. Many present day parts are machined out of heavy plate or blocks. Machining requires expensive equipment, and takes a great amount of time. Much of this cost will be eliminated.

Some Specific Savings

The over-all predictions of savings with Heavy Press fabrication, are the sum-total of the savings which can be

anticipated in the comparison of costs of parts produced by the presses with present day costs.

For example, a wing beam for a new fighter plane currently produced as a hammer forging weighing 259 lb. In the subsequent machining operation, 127 lb of material are cut away as chips. In a large press, this part will be produced as a forging weighing 155 lb with 23 lb being machined off.

A comparison of a combing system beam, produced by present methods, with a press-produced product shows that the present design calls for twenty-five individual parts, with 40 bolts, and 186 rivets. Cost is estimated at $444.00 per piece. On a heavy press, this item, it is estimated, will be produced as a single piece costing $298.00.

Another instance in which savings are obvious is the fuselage bulk-head from a new bomber. On the largest press available today, this part is made in two sections, which require extensive machining, and are joined with 4 bolts. Weight of the finished bulkhead is 98 pounds. On a Heavy Forging Press, this part will be produced in one piece, weighing 78 pounds.

For one of the new swept-wing fighter planes, entire sections of the wing can be produced as an extrusion, incorporating skin, stiffeners and spar caps in one piece.

In the period of approximately a year and a half that has elapsed since the original adoption of the Air Force program, major aircraft companies have made increasing use of heavy press forgings. Demands for press-fabricated parts have exceeded the capacity of the Wyman-Gordon and Adrian (Bohn Aluminum and Brass Co.) facilities, which contain 18,000 T and 15,000 T presses. Companies known to be using forgings on aircrafts now in production include Boeing Airplane Co., Republic Aviation Corp., Consolidated Vultee Aircraft Corp., Chance-Vought Aircraft Division, United Aircraft Corp., and Gruman Aircraft Engineering Corp.

This then is the Air Force answer to criticism. Some of the points are speculative, and some of the costs obviously are but estimates.

But in terms of productive capacity, that these presses can insure, they'll be worth many times their initial cost.

ATOMIC ENERGY DATA

COMPANIES READY TO PLUNGE into the atomic energy field heard two non-technical developments last month, one was encouraging, the other was not:

• In New York, businessmen, engineers, scientists and educators formed an Association—Atomic Industrial Forum, Inc.—to encourage industrial development and research in the new field.

• In Minneapolis, engineers heard a leading engineer repeat charges that over-classification of information by the Atomic Energy Commission was impeding peace time development of the atom.

Credit for the establishment of the new forum is attributed to Dr. T. Keith Glennan, president of Case Institute of Technology. Dr. Glennan proposed such an organization last year in a speech before the Manufacturing Chemists Association. His main purpose was to start a group that was independent of the government and whose aim would be to further the development of an Atomic industry.

Business men who joined in the formation of AIF include: Walker L. Cisler, president, Detroit Edison Company; John L. Collyer, president, B. F. Goodrich Company; John A. Martino, president, National Lead Company; John R. Menke, president, Nuclear Development Associates; Dr. Mark E. Putnam, executive vice president, Dow Chemical Company; Ross W. Thomas, vice president, Phillips Petroleum Company; Howard G. Vesper, vice president, Standard Oil Company of California; and Admiral Earle W. Mills, president, Foster-Wheeler Corporation.

Representing educational institutions are Dr. Glennon and Dr. Frederick L. Hovde, president of Purdue University.

According to Dr. Glennon, AIF will "provide a forum in which industry could develop its best thinking in the interest of the advancement of peacetime uses of atomic energy; a forum in which industry might develop an informed voice to be heard at government levels as new atomic energy policy is hammered out; a forum to stimulate the industrial development of atomic energy for the good of all".

AIF plans to accept two types of membership, regular and special. Only individuals, cleared for access to restricted data (as defined in the Atomic Energy Act of 1946) will qualify for regular membership. Special memberships will be open to individuals, corporations, associations or partnerships which are now or expect to be engaged in atomic energy.

Headquarters for the new group have been set up in the Engineering Societies Building in New York City.

While AIF was being incorporated, Col. William N. Carey, Executive Secretary of the American Society of Civil Engineers, was warning engineers that government restrictions were showing up progress in peacetime uses of atomic energy.

He pointed out, "much properly public information is kept restricted by several Federal departments behind a shield of alleged national security". Carey urged that revisions be made in the MacMahon Atomic Energy Act in the "interest of common sense and public good without sacrifice of security".

According to Carey, "private development is impossible in any important degree under present laws aimed at secrecy in the general program. A lead curtain has been dropped around our atomic discoveries and developments".

The Colonel touched on one other point that many companies have discovered the hard way. He urged a revision of engineering programs to train technical personnel for the new field. Atomic developments in industry are going to require better trained engineers. As Carey put it, "today's demand for quantity has been met with a sacrifice of quality. But while good enough for the immediate past, the quality (of engineers) will not be adequate for the needs of the future".

Atomic energy has become big business in its use of engineers, even under government monopoly. Today AEC employs almost 14,000 engineers and scientists, out of a national total of 400,000 engineers. As private enterprise enters the field, the number will increase rapidly. Carey pointed out that separating the engineer from the technician demand would ease.

"WRAP-AROUND" CONNECTIONS

AN ESTIMATED TEN-BILLION soldered connections a year presently being made by the American communications industry may be eliminated by a new connecting technique now in production at the Western Electric Company. The method utilizes a wire-wrapping tool, jointly developed by engineers of Bell Laboratories and Western Electric, to produce a gas-tight joint between terminal lug and the connecting wire in the assembly of electrical, electronic and electro-mechanical equipments.

The solderless wrapped connection not only reduces the labor cost per joint, but by removal of the human element, opens avenues of automation in the assembly of electronic equipment.

The tool for making these solderless connections is a hand-held gun that has a rotating spindle with an axial opening that receives the wire terminal, and a second opening radially separated from the axial opening into which the skinned end of the connecting wire is inserted. The gun rotates its spindle, which virtually shoots the wire around the terminal in a tight helix, making a firm mechanical metal-to-metal joint. Automatic positioning of the spindle makes for easy operation; controlled tension makes the highly uniform wraps. A terminal, rectangular in cross section having edges such as produced by a punch press is wrapped with about six turns of wire under high tension. Contact pressure in the finished connection is at least 15,000 psi for the life of the connection. The result of this high tension is an indentation of the wire at each of the four terminal corners that requires a force of approximately 10 lbs. to strip from the terminal; actually the metal phenomenon "solid-state diffusion" improves the bond as time goes on, with a tendency towards mass homogeneity.

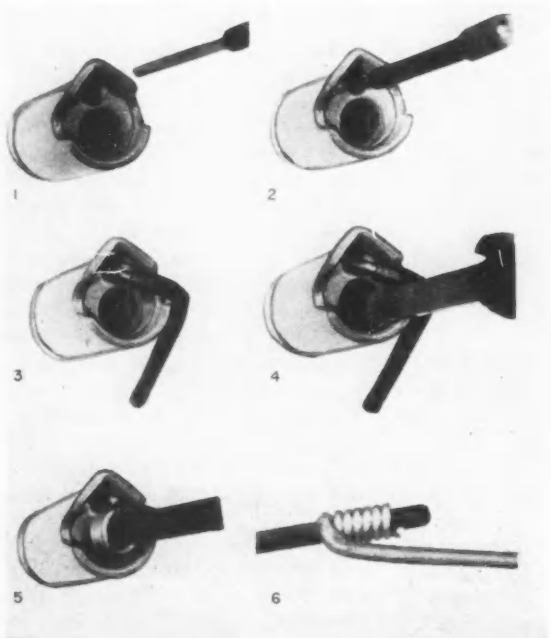
The tool can be powered either by air or electric motor, depending on which is most convenient in the plant.

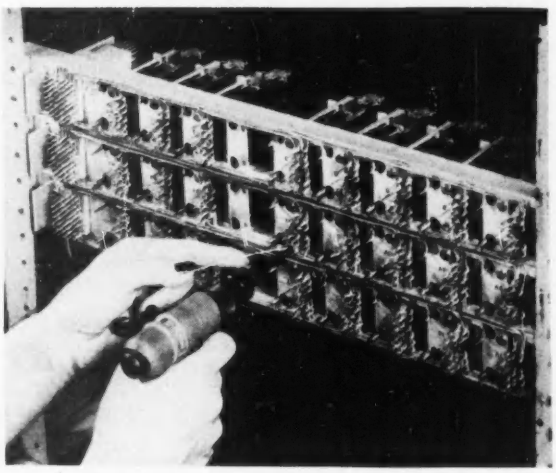
The connection is said to be mechanically stable, less apt to break through rough handling or vibration, and life expectancy is estimated to be at least 40 years without measurable resistance variations in the connection. The difference between the thermal coefficients of expansion of copper wire and nickel-silver or brass terminals have a negligible effect on the tightness of the joint; therefore the possibility of loosening of a joint because of ordinary temperature changes is nil.

Elimination of the soldering phase in assembly operations removes all the disadvantages of that method, the stray solder droppings, the "cold" joints and the damaging of adjacent parts by heat. Clipping excess wire from a soldered connection, which is often a cause of trouble in wired equipment, is not necessary because the wire end is part of the junction. With the solderless connection, terminals can be smaller in cross section, and spaced more closely together. Since the wrapped connection requires a minimum of space, equipment can, as a result, be reduced in size.

Introduction of wire wrapping will effect the design of terminals in existing equipment, although satisfactory connections can be made with the new tool on some terminals now in use. The design trend, at least in telephone applications, will be toward incorporation of close-proximity terminal arrangements that will be adaptable to the use of wrapped connections.

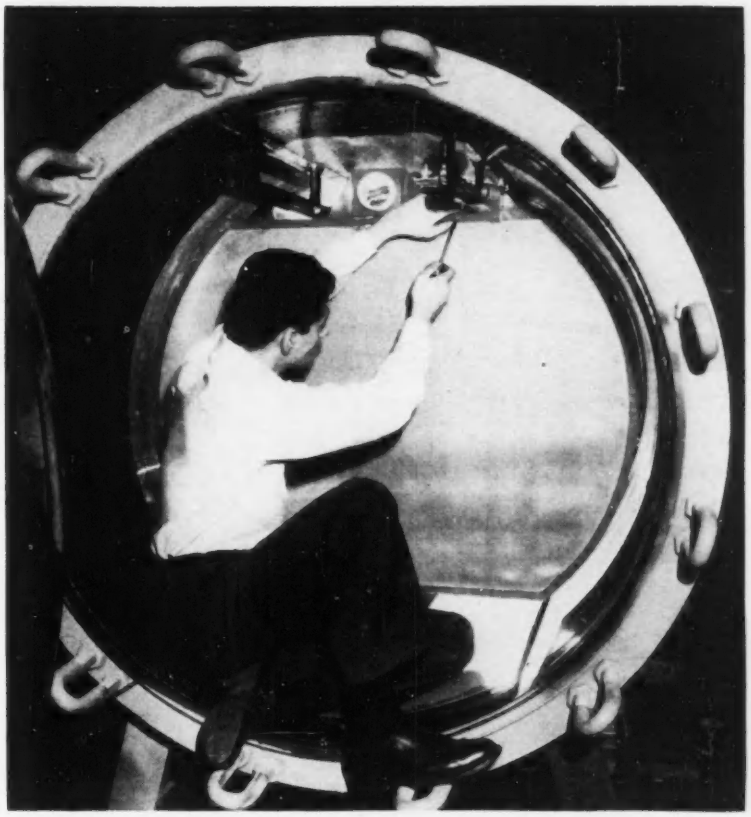
Although the Western Electric Company does not plan to produce the tool, it will be made commercially available to radio, television, and communications companies.





THIS ELECTRICAL ASSEMBLY illustrates the closeness with which terminals can be spaced. The technique is adaptable to control panels as well as all types of communication equipment.

(LEFT) SEQUENCE IN "solderless" wrapping: (1) tool tip; (2) wire inserted; (3) wire anchored; (4) terminal inserted; (5) wire wrapped; (6) finished connection.



EVEN NUTS AND BOLTS are made of rigid vinyl plastic in this filter that replaces settling tanks used by an automobile battery manufacturer.

PLASTIC FILTER

TODAY, DESIGNERS ARE moving plastics out of the class of "cheap substitute" design materials. Properties of improved and newly developed plastics have forced designers to take a second look at the synthetics. As a result, more and more parts are being fabricated from them, regardless of the metal supply situation. Typical of this new trend—where plastics compete on their own properties rather than price or availability—is an industrial filter unit recently designed by the Hercules Filter Corporation, Paterson, N. J.

In the leaf-type filter, B. F. Goodrich's Geon rigid vinyl plastic replaces metal alloys in such parts as: filter leaf frames, nuts and bolts holding the leaves in place, the heel plate, and various pipe fittings. And a flexible vinyl sheeting protects the inside of the tank from corrosion.

From a mechanical standpoint, the filter is a horizontal cylindrical tank with the leaves suspended vertically inside. Each leaf unit consists of a frame which holds a heavy mesh screen sandwiched between two finer mesh screens.

Besides serving as a support to the very flexible fine mesh screen, the heavier screen acts as a spacer for draining the liquid into discharge channels.

In this application, Hercules chose vinyl plastics because of high corrosion resistance. Tests indicate that a 140 F mixture of manganese sulphate and manganese dioxide, to which Geon is relatively resistant, eats through stainless steel in a few hours. The material also resists the effects of other acids, alkalis, solvents, greases and oils.

There's one added benefit. Metal alloys formerly used cost three to four times as much as the plastics.

NBS MAGNET MAGNETIZER

A MAGNETIZER for permanent magnets that has recently been constructed at the National Bureau of Standards requires few parts and weighs only 21 lb. It operates from a 110-v. a-c supply, draws about 30 watts, and has peak magnetomotive forces as high as 20,000 ampere-turns.

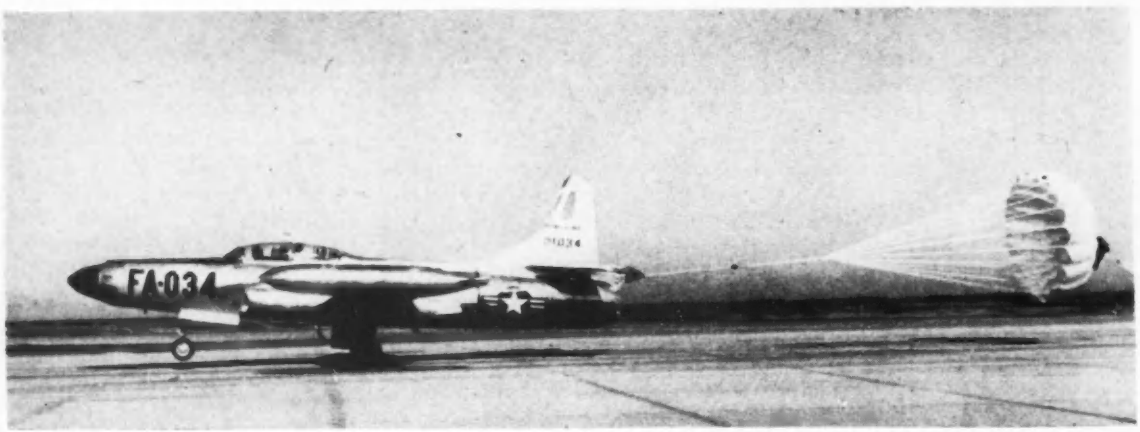
The Bureau's device is a form of "flash" magnetizer in which a large capacitor is quickly discharged through the magnetizing coil. Although flash magnetizing may not be fully effective for large magnets (the short duration of the magnetizing pulse does not always permit the magnetizing flux to reach full value below the surface of the magnet), it is often quite satisfactory for smaller ones.

A 6,500 μuf capacitor bank is charged to about 215 by selenium rectification of the a-c line voltage. Energy stored in the capacitor is transferred to the magnetizing coil by a heavy-duty 24-v. 70 ampere motor-starting relay. The relay coil is actuated by a push switch. Since the relay gets its operating power from the capacitor bank, it opens shortly before the capacitor voltage has fallen to zero. Because the relay contacts thus open at a time when the current through them is low, high current-interrupting capacity is unnecessary.

The unit was built at the Bureau at a total cost of less than $50, using mostly war surplus parts. Capacitors rated at 650 μuf, 80 v d-c were obtained for about $1.50 each; after a forming period they operated satisfactorily at 125 v. Power consumption varies between 70 w (capacitor discharged) and 10 w (capacitor charged); at the normal rate of magnet charging—one pulse every 15 sec—the average line power drain is no more than 30 watts. Because of this low power requirement, the unit can operate from batteries for portable use.

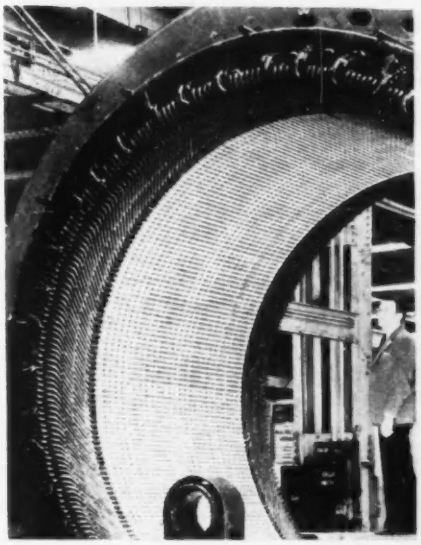
Several magnetizing coils have been constructed for the magnetizer, of designs that varied with the shape of the object to be magnetized. Although iron yokes are necessary for multipolar or radial magnetizing, simple layer-wound solenoids are satisfactory for general use. Optimum coils have from 150 to 200 turns, and a d-c resistance in the range of 0.3 to 1.0 ohm.

THE NEWS IN PICTURES



LANDING SEQUENCE OF THE F94-C STARFIRE, the Air Force's all-weather radar equipped jet interceptor which is built by Lockheed. First American production aircraft to be equipped with a parachute brake, the plane can land in half the distance that would be necessary without the device. The Fist (ribbon) type parachute is 16 ft in diameter, has a 24 percent porosity, and a drag coefficient of 0.49. It is connected to the plane through a 10 ft nylon line that is shielded from heat by Fiberglas.

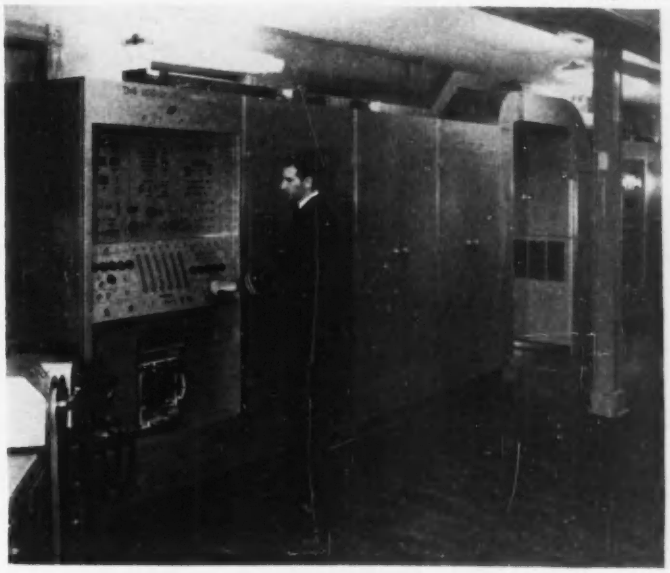
The mechanical part of the deployment system works in the following sequence: (1) The pilot pulls the chute operating lanyard located in the cockpit compartment flow on the left hand side. The first lanyard movement locks the hook to the link on the end of the drag line. (2) Further movement of the lanyard releases the spring-bungee-loaded doors, which snap open, releasing the pilot chute, drawing the deployment bag from the compartment, and starting the opening cycle. (3) After completion of the landing roll, the pilot rotates the lanyard handle 180 deg and the next movement unlatches the hook in the tail cone, jettisoning the chute. The system is designed for a 200 knot maximum speed, and deployments have been made at speeds down to 40 knots. Usual operation is from approximately one ft above the runway or just after contact.



STATOR for one of four motors being built by GE for the Moffet Field, Calif. supersonic wind tunnel that will be used to clock aerodynamic characteristics of aircraft and guided missiles. Each motor will generate 216,000 hp and weigh 685 T. Stator in foreground is for a 5 hp motor.

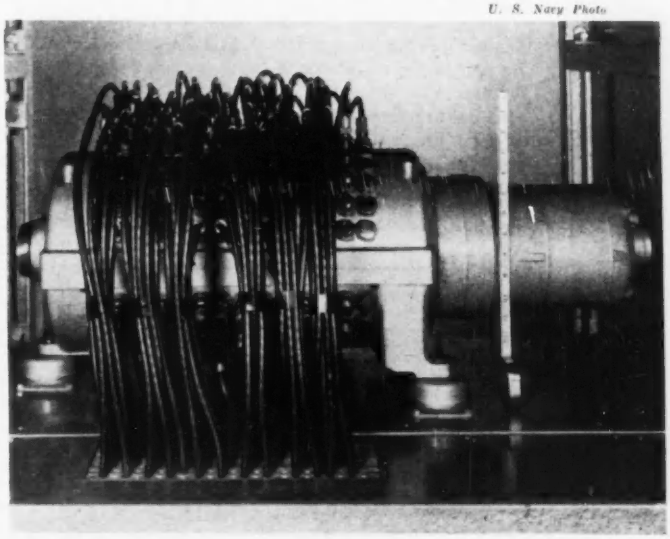
COMPUTER constructed by Engineering Research Associates from designs and specifications of Office of Naval Research and George Washington University. The computer was developed for application to problems in logistics. Capable of adding 1,000—10 digit numbers and arriving at an answer in 0.5 sec, the machine uses 3,500 vacuum tubes. Three 11 ton refrigerating compressors cool the computer during operation.

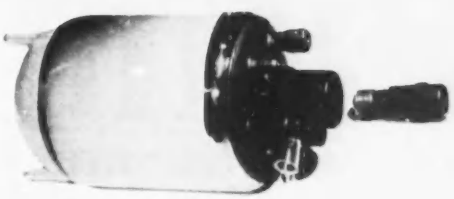
U. S. Navy Photo

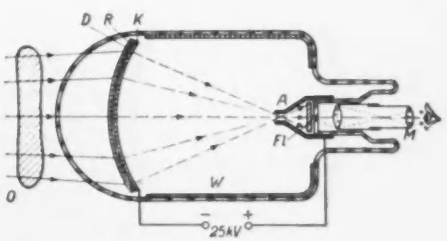


MEMORY DEVICE used in the logistics computer are stored in a magnetic drum. Data is stored in the form of electrical charges in cells located around the periphery of the drum, and information is read out by magnetic heads that show as the terminals of the wires. (Details of the construction and operation of such devices will be featured in the July issue of *Product Engineering*). The input unit of the computer receives its data initially from punched tape. An arithmetic stage performs mathematical operations on the input data and works in conjunction with the storage unit which holds intermediate results as they are computed. Output is in the form of punched tape which is converted later to typewritten data by a tape reading machine.

U. S. Navy Photo

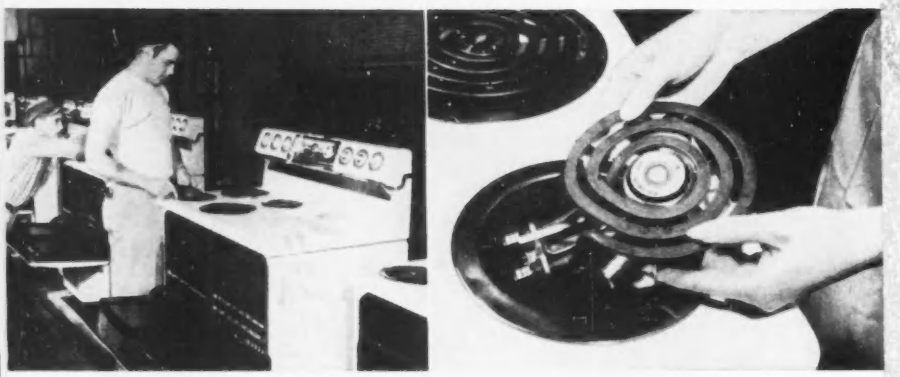






X-RAY IMAGE INTENSIFIER that produces images 800 to 1,000 times brighter than those obtained with a conventional fluoroscope. Developed by Philips Laboratories, Eindhoven, Holland, the device has a curved fluorescent screen in direct contact with a photocathode inside the hemispherical end. A screen at the other end and an external optical microscope complete the construction. North American Philips Company, Inc. distributes the device.

SILASTIC helps Westinghouse score another FIRST...*
"COOKING without LOOKING"



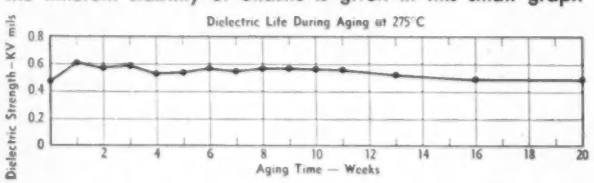
Engineers have been working for years to make a heat control system for electric range surface units that would forever banish pot watching. But it took Westinghouse, using a bit of Silastic, a thermistor, and a few relays and vacuum tubes, to perfect the "Electronic Eye." This heat control system regulates the temperature so accurately that food can be warmed, boiled or fried without danger of burning or scorching—even if all the water is boiled away. The heart of the temperature measuring device, the thermistor, is embedded in Silastic paste for protection and heat transfer. Flexible Silastic insulated cable is used to connect the thermistor to the exterior wiring, and the Electronic Eye itself is isolated in the center of a flexible Silastic diaphragm. The Silastic components have stood up under exposure to boiling water, oil, grease, coffee and syrup, as well as accelerated life testing equivalent to 15 years of actual service.

Performance proves...

SILASTIC works

where other materials fail!

Many of the most able designers, like those Westinghouse men who made automatic cooking a practical reality, save time and money by trying Silastic first when they need rubbery properties at temperatures far above or below the limits of any ordinary rubber. And exceptional stability at both high and low temperatures is combined in Silastic with excellent resistance to outdoor weathering and good resistance to a variety of hot oils and chemicals. Further proof of the inherent stability of Silastic is given in this small graph showing the effect of aging at 275°C (527°F) on the dielectric strength of Silastic.



Dielectric strength measured with ¼ inch electrodes in air on two layers of Silastic R Tape, for example, average 0.475 KV per mil. After 20 weeks of continuous aging at 275°C with both surfaces exposed in an air circulating oven, dielectric strength gradually decreased from a high of 0.601 to 0.485 KV per mil.

That's the kind of performance that makes Silastic, the Dow Corning silicone rubber, unique among all rubbery materials. When you need rubbery properties at temperatures above 150°F or below —40°F, or excellent dielectric properties in a resilient and flexible material ***specify Silastic.***

*T. M. REG. U. S. PAT. OFF.

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Charts for Allowable Compressive Stresses in Aluminum and Magnesium Alloys

B. E. GATEWOOD
Department of Mechanics
USAF Institute of Technology

DERIVED from theoretical procedures and test data given in NACA and aircraft company reports, these charts show the allowable compressive stresses in both the elastic and plastic regions for structural elements. They are based on a non-dimensional compressive stress-strain curve that is applicable to all aluminum and magnesium alloys. The allowable stress is given in terms of non-dimensional parameters, S and B, which are functions of σ_{cy}, the compressive yield stress of the material, the modulus of elasticity, E, the buckling coefficient, K, the maximum stress coefficient, M, and the geometry of the element. Types of allowable compressive stresses that can be obtained are listed below. Definitions and procedures are indicated for each; Ref. 7 gives derivations and discussions. In each example, the geometry of the structual element and the material are assumed to be given so that E and σ_{cy} are known. Since K and M can be read from Figs. 3 and 4, B can be calculated and S obtained from Fig. 1 or Fig. 2. The value of S with the known, σ_{cy}, gives the desired allowable stress as shown.

1. Compressive buckling stress (σ_{cr}) of flat plates—Use curve for plates in Fig. 1 with

$$S = \frac{\sigma_{cr}}{\sigma_{cy}}, \quad B = \sqrt{\frac{\sigma_{cy}}{KE}}\left(\frac{b}{t}\right)$$

where b, t, σ_{cy}, and E are given, K is from Fig. 3, and σ_{cr} is the desired buckling stress.

2. Compressive maximum stress (σ_{cc}) of flat plates—Use Fig. 2 with $M = 0.48$, B and K as for compressive buckling (1). Then

$$S = \sigma_{cc}/\sigma_{cy}$$

Note that $\sigma_{cc} = \sigma_{cr}$ for $B < 1.63$.

3. Shear buckling stress (σ_{cr}) of flat plates—Use σ_{sy} instead of σ_{cy} in procedure for compressive buckling (1) with K for shear from Fig. 3. For aluminum alloys σ_{sy} is approximately $0.6\ \sigma_{cy}$.

4. Bending buckling stress (σ_{cr}) of flat plates—Use same procedure as for compressive buckling (1) with $K = 21.6$. *(continued on page 237)*

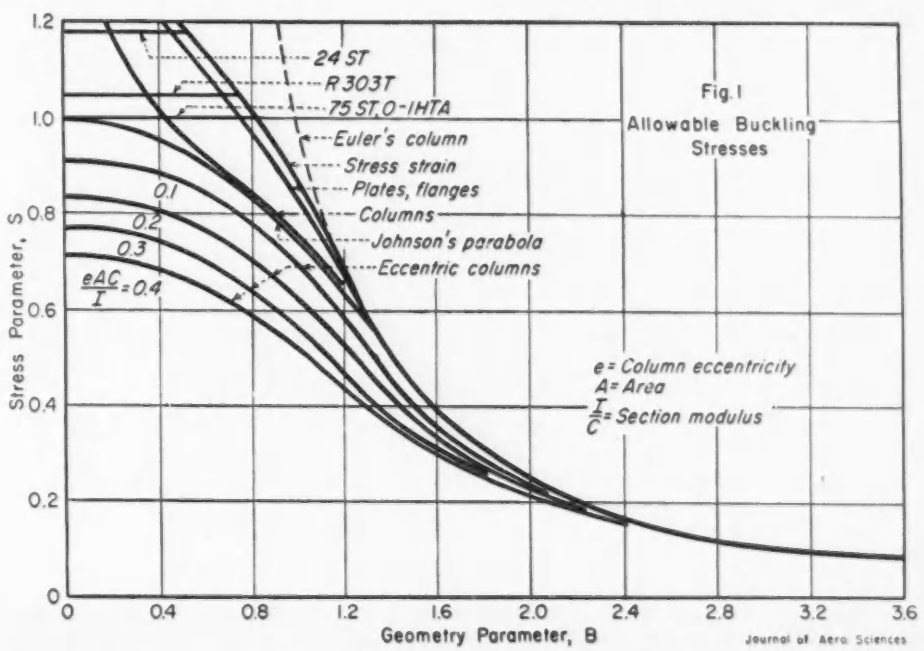

Fig. 1 Allowable Buckling Stresses

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5. Interrivet buckling stress (σ_c) of flat plates—Use Euler's column and Johnson's parabola in Fig. 1 with

$$S = \frac{\sigma_c}{\sigma_{cy}}, \quad B = \sqrt{\frac{\sigma_{cy}}{E}}\left(\frac{1.72}{\pi}\right)\left(\frac{s}{t}\right)$$

where s, the rivet spacing, t, the plate thickness, E, and σ_{cy} are given and σ_c is the desired buckling stress.

6. Column stress (σ_c) for sections with stable cross-sections—Use Euler's column and Johnson's parabola, or eAc/I curves for eccentric loading, in Fig. 1 with

$$S = \frac{\sigma_c}{\sigma_{cy}}, \quad B = \sqrt{\frac{\sigma_{cy}}{E}}\left(\frac{1}{\pi}\right)\left(\frac{L'}{\rho}\right)$$

where L', the effective column length, ρ, radius of gyration, σ_{cy}, and E are given. Desired column stress is σ_c.

7. Column stress (σ_c) of sections with local instability—Use Euler's column and Johnson's parabola, or eAc/I curves for eccentric loading, in Fig. 1 with

$$S = \frac{\sigma_c}{\sigma_{ce}}, \quad B = \sqrt{\frac{\sigma_{ce}}{E}}\frac{1}{\pi}\left(\frac{L'}{\rho}\right)$$

σ_{ce} is crippling stress from (10).

8. Bending crippling stress (σ_{cc}) of sections with local instability—Use Fig. 2 with M and K from Fig. 4(C) B as in item 9. $S = \sigma_{cc}/\sigma_{cy}$.

If K is not known for the section obtain a value of B for each element of the section, use B in Fig. 1 to obtain the stress for the element and average all elements ($\Sigma\sigma A/A$) to obtain σ_{cc} for the section. If the section has lateral instability, then the above value must be reduced.

9. Compressive buckling stress (σ_{cr}) of sections with local instability —Use plate curve in Fig. 1 with

$$S = \frac{\sigma_{cr}}{\sigma_{cy}}, \quad B = \sqrt{\frac{\sigma_{cy}}{KE}}\left(\frac{b}{t}\right)$$

K in Fig. 4, and Ref. 1, a; b, t, E, and σ_{cy} are given; σ_{cr} is the desired buckling stress.

10. Compressive crippling stress (σ_{cc}) of sections with local instability —Use Fig. 2 with M from Fig. 4, B and K as for compressive buckling (item 9) with

$$S = \sigma_{cc}/\sigma_{cy}.$$

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(continued on page 239)

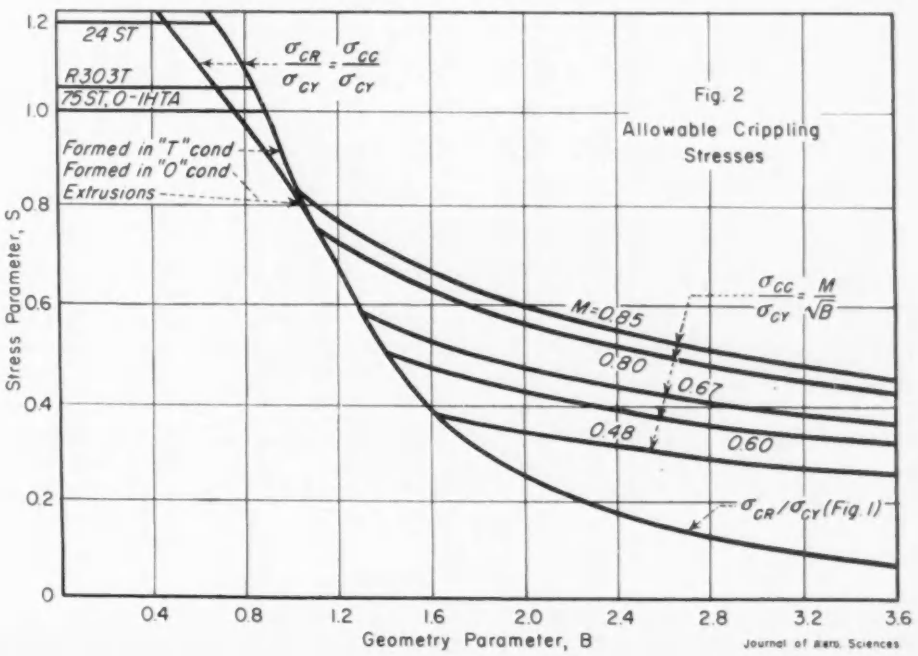
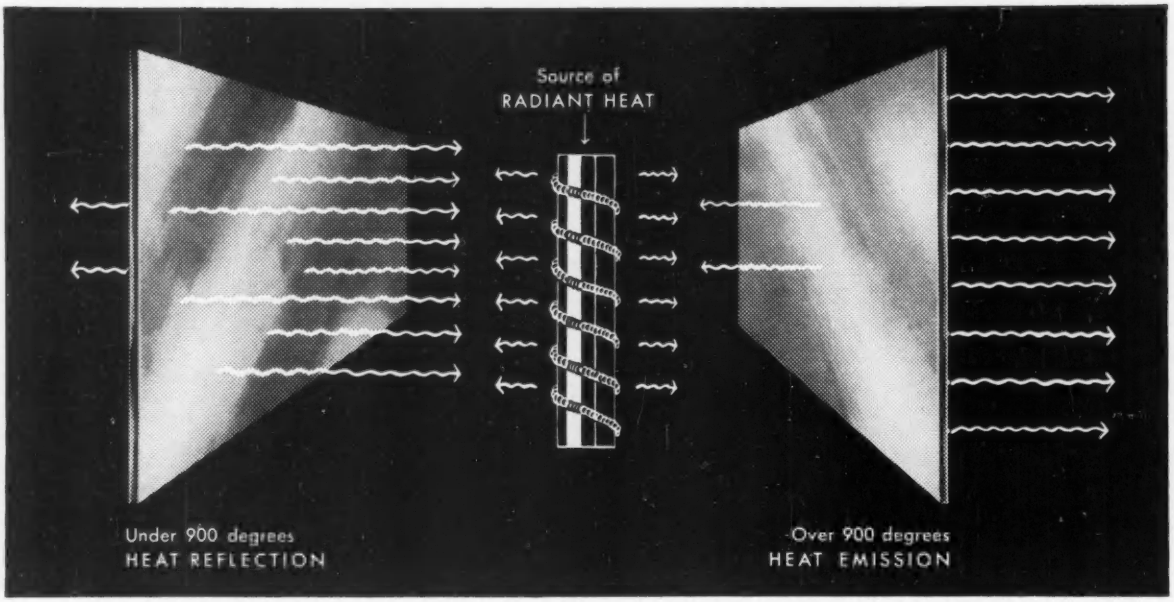


Fig. 2
Allowable Crippling Stresses

Steel that REFLECTS Or EMITS Radiant Heat



Armco ALUMINIZED Steel, the steel with a hot-dip aluminum coating, is used for *either reflection or emission* of radiant heat.

At service temperatures under 900 degrees F, the aluminum coating is an excellent reflector of heat. Service at over 900 degrees F permanently changes the ALUMINIZED Steel from a reflector into an efficient emitter of radiant heat. That's because the aluminum coating alloys with the steel base, forming a tight gray surface layer of iron-aluminum alloy. This also gives the steel an unusually good refractory coating.

In its heat-reflection range (under 900 degrees F), Armco ALUMINIZED Steel is used for such parts as reflector panels for infra-red ovens, broiler reflectors and many other parts of ranges. In its heat-emitting range (above 900 degrees F) it is ideal, for example, in combustion chambers of oil and gas furnaces.

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Allowable Compressive Stresses in Aluminum and Magnesium Alloys (continued)

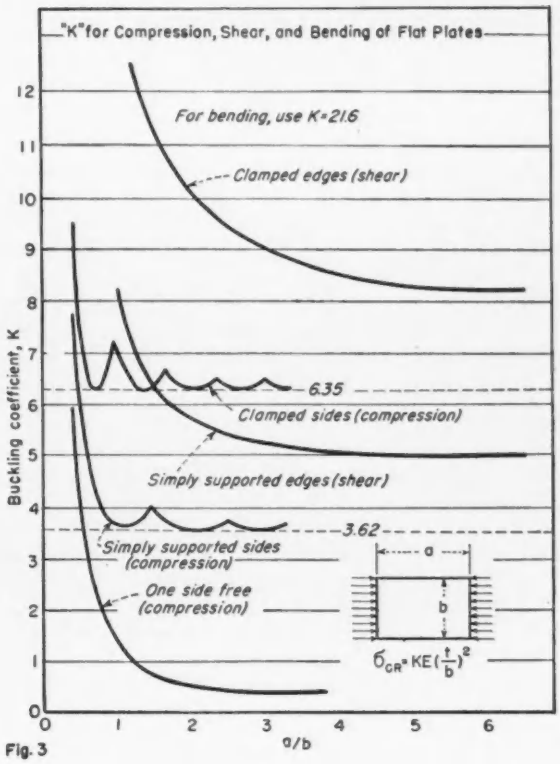


Fig. 3

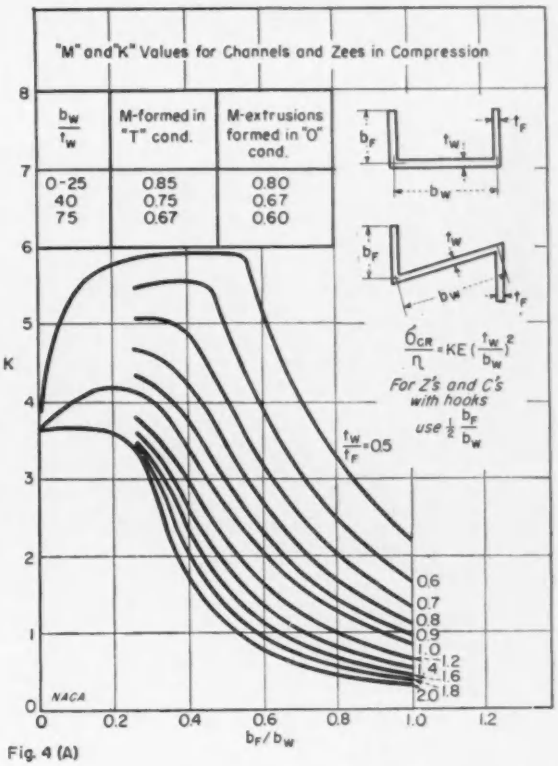


Fig. 4 (A)

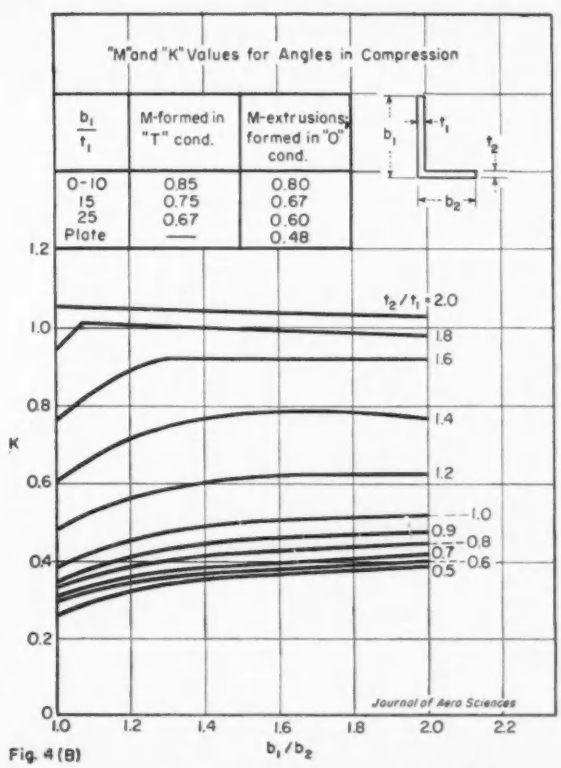


Fig. 4 (B)

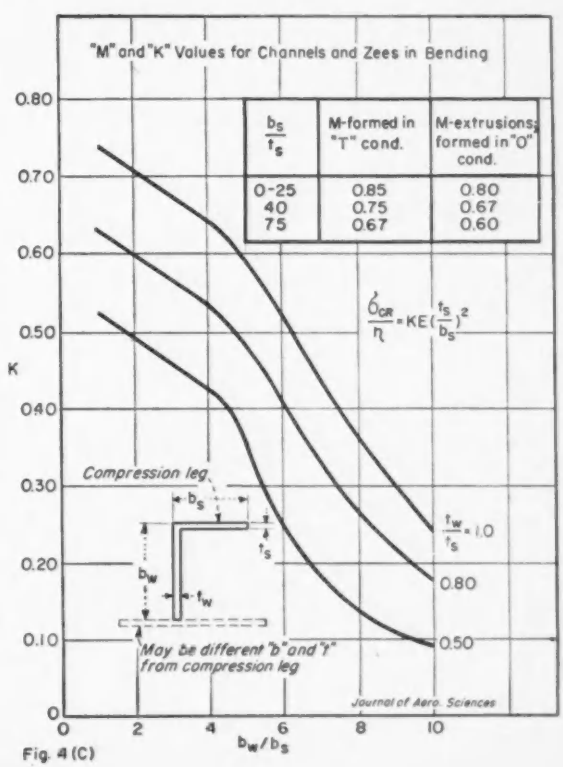
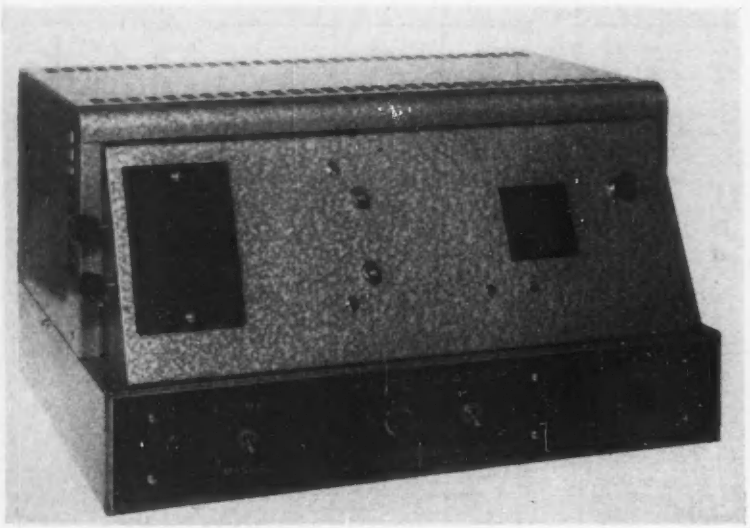

"M" and "K" Values for Channels and Zees in Bending
$\frac{b_s}{t_s}$ | M-formed in "T" cond. | M-extrusions formed in "O" cond.
0-25 | 0.85 | 0.80
40 | 0.75 | 0.67
75 | 0.67 | 0.60
$\frac{\sigma_{CR}}{\eta} = KE(\frac{t_s}{b_s})^2$
Compression leg
$\frac{t_w}{t_s}$ = 1.0
0.80
0.50
May be different "b" and "t" from compression leg
Journal of Aero. Sciences
K
b_w/b_s

Fig. 4 (C)



High Speed Response In Electro-Mechanical Integrator

Combining the advantages of mechanical and electronic integrators to give features of high speed response and unlimited output, this electromechanical device is based upon the principle of a precisely controlled variable speed drive whose output speed is proportional to the input signal that is to be integrated. Some of its applications are: integration of stress-strain curves; continuous process weighing; analysis of graphical data; and total water contents.

The integrator assembly uses a velocity-servo circuit, in which a small variable speed controlled motor is coupled to a d-c tachometer, which in turn produces a voltage that is closely proportional to its speed. This tachometer voltage is compared against the input signal, and any difference or error between the two is greatly amplified and made to operate the motor at such a speed as to eliminate the error. In this way the motor speed is always a linear function of the value of the input voltage.

In addition, there is an electronic circuit in the amplifier which integrates instantaneously any transient error that may occur between the input signal and the tachometer voltage. This error might arise, as a result of a sudden change in the input signal, and because of the necessarily finite time for the motor to accelerate to the corresponding speed. The action of the circuit causes the speed of the motor to overshoot sufficiently to cancel the previous error of integration. By this means, the final output integral may be accurately determined in spite of fluctuations of the input integrand.

The output counter is so arranged that a full scale input signal will yield an integrating rate of 5,000 counts per minute. Calibration of the device, for a given full scale input, is made by adjusting the speed of the motor against the line frequency. The zero adjustment is made by another ten-turn potentiometer, and is obtained by causing the motor output to be stationary for a given zero input signal.

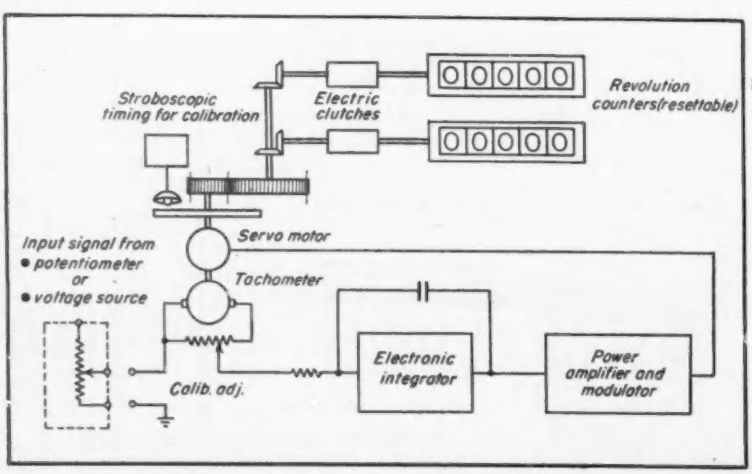
The motor drive is completely reversible and the electronic circuits respond equally to either plus or minus signals. Therefore, the device will subtract negative integrated values with the same accuracy as additive values.

Integration of two independent signals (x and y) with respect to each other can be performed, provided that they are in the form of mechanical motions or can be converted to mechanical form. One of these motions, x, can be made to drive an auxiliary d-c tachometer, whose output will be a voltage proportional dx/dt. This voltage is connected across a potentiometer whose shaft is driven by the other mechanical variable y. Thus, the output of the potentiometer will then be a function of the form $y\frac{dx}{dt}$.

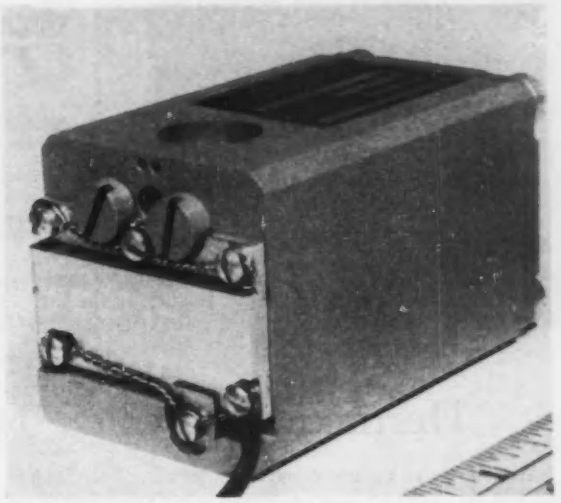
If this new variable is integrated, the output of the integrator will be:

$$\int\left[y\frac{dx}{dt}\right]dt = \int y dx$$

Instron Engineering Corp., 2 Hancock St., Quincy 71, Mass.



Electro-Hydraulic Pressure Control Servo Valve



THE PC-1 SERVO VALVE, in addition to supplying the advantages of pressure control in a small unit, also has good static and dynamic performance characteristics.

Operating with supply pressures from 500-3,000 psi, this new pressure-control servo valve is used to regulate the differential pressure of hydraulic fluid at the output ports proportional to an electrical input signal. Its basic design gives linear operation throughout the entire range. Principle applications are in high performance position servos, velocity or speed control servos, and acceleration or force regulators.

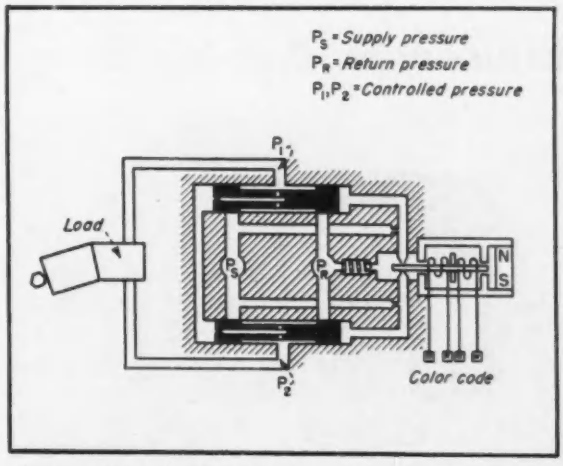
In application the valve is usually connected to either a hydraulic motor or actuator. These combinations produce torque or force servo controllers with high torque-to-inertia ratios and horsepower outputs. The inertia of these controllers is usually so low that the combinations may be considered good torque or force sources. As such they eliminate the stability problems due to the effect of system compliance. Thus, the performance of the servo systems is increased beyond the normal load natural frequency.

Maximum differential pressure output of ± supply pressure is obtained with an 8 ma differential current input to the two 700 ohm actuating coils. Power rating with 3,000 psi supply is 4.2 hp. Weight of the unit is 1.4 pounds. High power amplification is obtained with a miniature electrical torquer hydraulically connected to a pair of push-pull slide valves which regulate the output pressures.

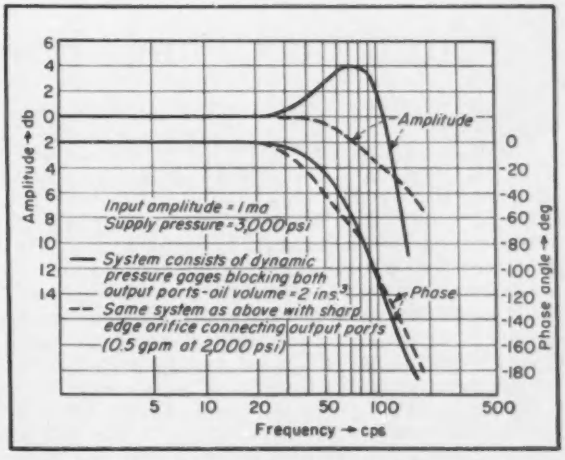
Other specifications are—temperature operating range: —65 F to +250 F; acceleration sensitivity: no measurable effect on pressure regulation at ±10 g any axis; hysterisis: maximum equals 200 psi differential pressure; flow characteristics: differential pressure droop at a flow of 3.6 gpm less than 1,000 psi; effect of supply pressure changes: maximum shift in differential pressure for supply pressure change from 3,000 to 2,000 psi is equivalent to 0.5 ma.

Typical applications are in the control systems of aircraft, guided missiles, rockets, radar antenna, fire control equipment, automatic machine tools, and process control.

Standard Controls, Inc., 1230 Poplar Pl., Seattle 44, Wash.

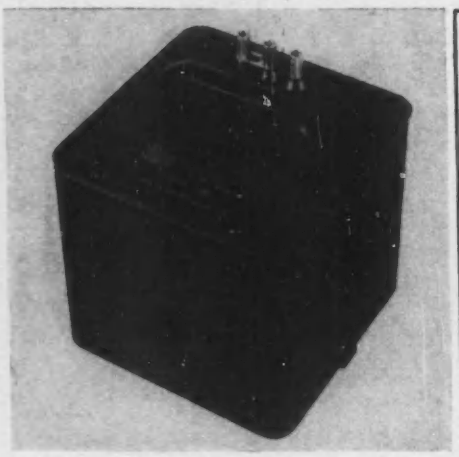


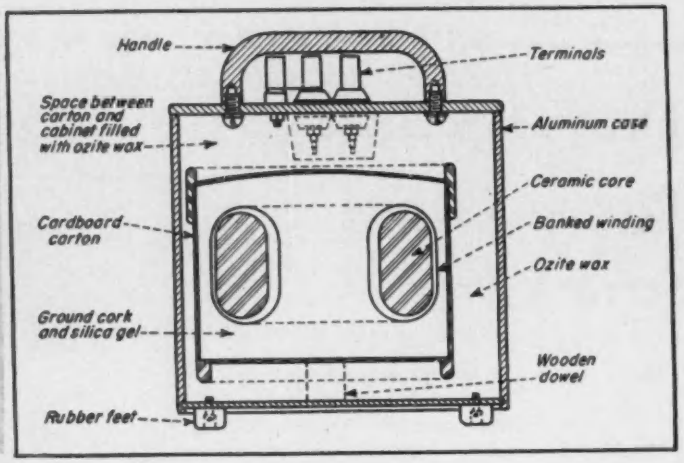
A SCHEMATIC VIEW of the valve. The electrical connections are 8 in. 4 wire color coded cable. Minimum burst pressures are 7500 psi for pressure sections, and 3000 psi for return sections.



FREQUENCY RESPONSE CHARACTERISTICS are shown on the graph as the transfer function of the differential pressure output and input current for two systems.

CONTINUED ON PAGE 242





Hermetically Sealed Toroid Inductors

A new series of inductors having symetrically wound toroids are said to have a higher degree of astaticism than in the older type having an adjacent pair of D-shaped coils. They have essentially no pick-up from a moderately uniform electro-magnetic field, and when energized, they produce no such field in their vicinity. Therefore, they may be used close to each other or to other circuit components.

The new type 1482 toroidal inductors are wound on a low thermal expansion ceramic core having an elliptical cross section to avoid sharp bends in the winding. After adjustment, they are packed in granulated cork into a cylindrical cardboard carton, together with a small amount of silica gel to insure dehydration. The carton is supported on three wooden dowels and completely cast with a potting compound into the aluminum case. Uniformly supported and hermetically sealed, these inductors have a high degree of stability, and their temperature coefficient of inductance is positive, and about 30 parts per million per degree C.

These inductors are offered in 1-2-5 unit values, which permits a direct comparison between them on a unity ratio bridge. Inductance values extend from 100 μh to 1h inclusive. These are adjusted with a nominal limit of ±0.1 percent of absolute inductance except the 100 μh and 200 μh units having a nominal limit of ±0.25 percent.

Due to the thermal insulation given by the granulated cork, the input power should be limited to 3 watts, which produces a 20 C temperature rise in the windings, and for precise work a limitation of 200 milliwatts, less than a 1.5 C rise, may be taken.

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

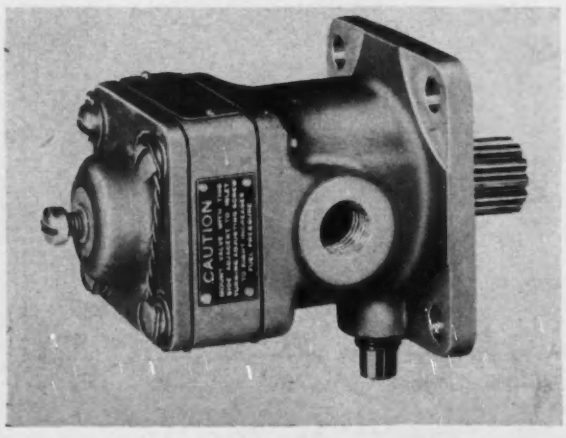
Small Fuel Pump Has Built-In By-Pass Valve

Designed for engines of 250 hp maximum, this fuel pump has a displacement of 0.067 cu in./rev, and a rated capacity of 2 to 30 gal per hour at 3,700 rpm with an outlet pressure of 15 psi. The excess flow, relieved through the relief valve, recirculates in the pump.

The pump operates in either direction, and may be used with ordinary aviation gasoline or special blends. The pump is of the rotary vane type, positive displacement.

A balanced relief valve is adjustable for any requirement of the engine between 8 to 20 psi, with the lower range available by using a lighter valve spring. A built-in by-pass valve aids fuel passage through the pump, as from starting and emergency source.

The model RD-7420-B fuel pump is used in aircraft, and the RD-7420-AJ on marine engines. The pumps operate satisfactorily at speeds to 4,500 rpm, and have continuous flow at idling speed.



Lear, Inc., Romec Div., Elyria, Ohio

CONTINUED ON PAGE 244

WICHITA 24" *Air-Tube* Clutches Disengage in

1/27 of a second

SMALLER CLUTCHES EVEN FASTER!

For complete safety of the operator, split second disengagement is absolutely *essential!* The amazing disengagement speed of Wichita Air-Tube Clutches is due to minimum volume of air in tube and to Wichita Quick Release Valves.

Wichita Clutches are operated successfully, on many types of equipment, all over the world and *NOT ONE HAS BEEN REMOVED*. This alone proves the superior performance of Wichita Clutches. Test a Wichita . . . you'll see for yourself!

Other Major Features

- **Soft, Smooth Engagement**
- **Simple Design**
- **3 types of clutches: Standard, Low Inertia, Special Ventilated**
- **Efficiency Engineered**
- **Positively Ventilated for Cooler Operation**
- **Extremely Long Life**
- **Easier Maintenance**

Consult your nearest Wichita Engineer for complete and detailed information.

WICHITA DISTRIBUTORS

Brahm-Lehner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., (Main office) West Hartford, Conn.
Smith-Keser & Co., Philadelphia 44, Pa.
Smith-Keser & Co., New York, N. Y.
Frank W. Yerline Co., Chicago, Ill.
Power Rig & Equipment Co., Inc., Long Beach, Calif.

Ad 4DN

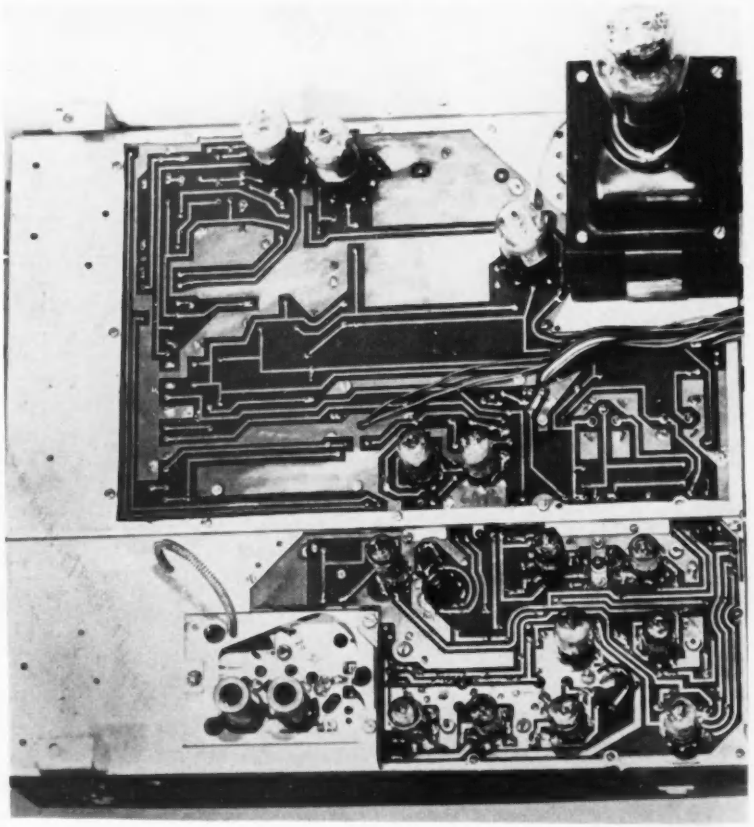
Printed Circuit Has Different Bonding Method

Using a different method of bonding the pattern to the insulating base, the conductive pattern of a printed circuit can be run from one side of the base material to the other by plating through holes, and maintaining circuit continuity without the need for eyelets or other hardware. This permits crossovers, design flexibility, and easy adaptation to single-dip soldering.

Copper, silver, and other metals in any thickness can be used for the conductive circuit, and to supply high wear resistance. The pattern can be overplated with nickel, silver, rhodium, or gold. Called circuitrons, they can also be supplied with a solder or tin coating to reduce oxidation and aid in dip soldering. The conductive pattern can be applied to such base materials as phenolics, melamines, silicones, polystyrene, polyesters, and teflon. The circuit pattern can be any thickness.

In addition to replacing wires, switches, and terminal boards, one circuitron replaces some types of coils and capacitors. The conductive pattern can be made flush with the surface of the insulating base material, improving barrier insulation between circuits, and making the circuitrons adaptable for use as non-shorting switch assemblies or commutator rings.

Circuitron, Inc., 400 Ninth St., Hoboken, N. J.

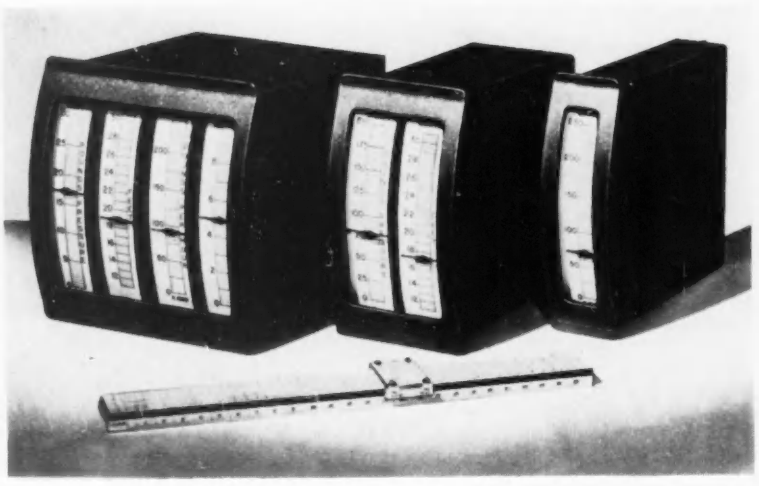


Space Saving Indicators For Panel Mounting

Specially designed for panel mounting, these multiple purpose vertical scale gages known as Mindicators, are used on graphic or process control panel boards as receivers, and as direct reading gages and thermometers. When designed as receivers for instrument control panel boards, they operate on transmitted pressure of 3 to 15 psi, using individually calibrated metallic bellows measuring elements.

Direct reading thermometers are available in any scale range from as low as —200 F to as high as 1,000 F. These thermometers are equipped with spiral bourdon tubes, and flexible stainless braid armored capillary connecting tubes for any length to 150 feet.

The Dickson Co., 7420 Woodlawn Ave., Chicago 19, Ill.



CONTINUED ON PAGE 246

The POWER that Builds Reputations

KNOWLEDGE

SKILL

SERVICE

RESPONSIBILITY

A.D. THE PEERLESS ELECTRIC COMPANY 1893

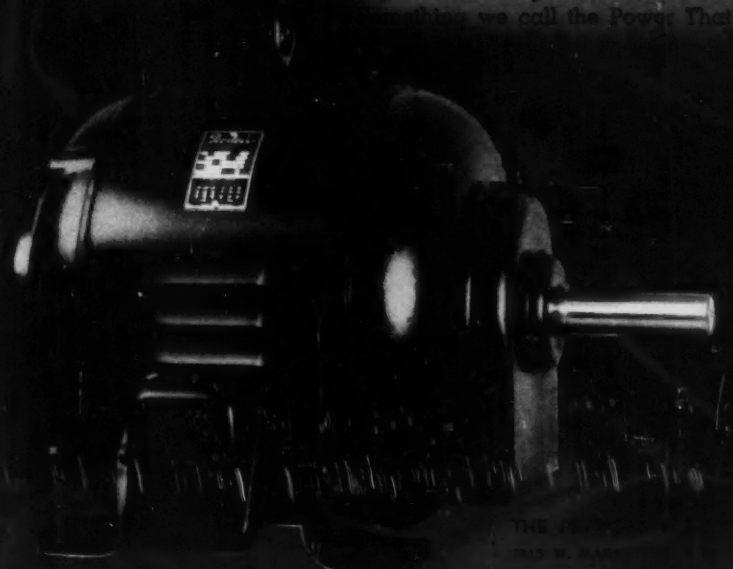
Peerless

PREMIUM-BUILT ELECTRIC MOTORS

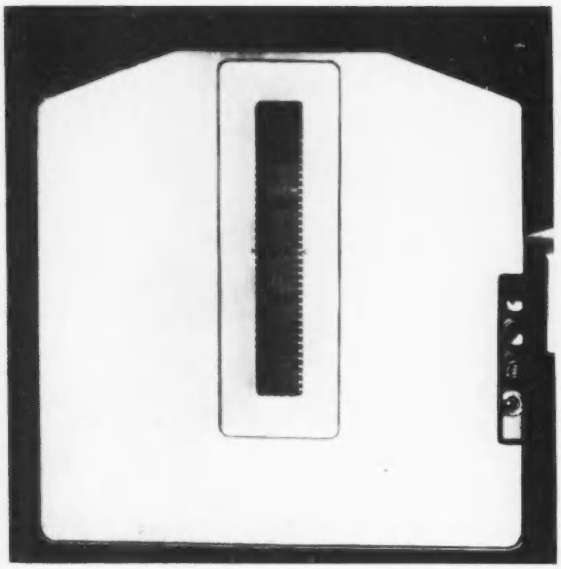
No greater compliment can be paid a motor than to call it Peerless. The men who build, sell and service America's finest mechanical equipment know what we mean.

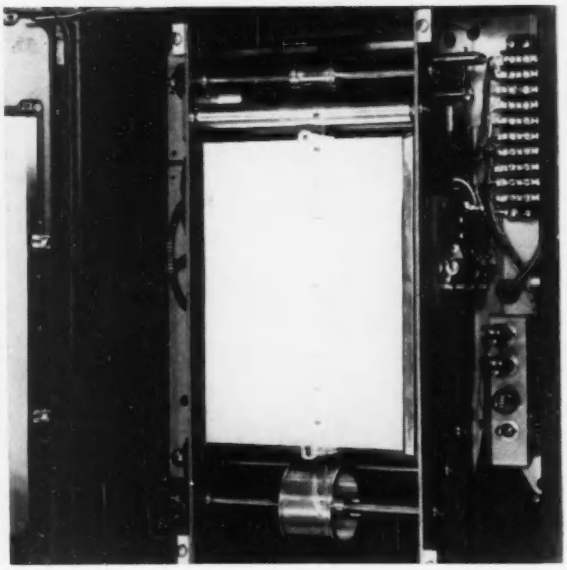
"Service" by our representatives; "knowledge" of Peerless engineers; "skills" of its manufacturing personnel; and, "responsibility" of Peerless top management result in a motor with that extra something. Yes, The Peerless Electric Company is proud to build motors with that extra something . . .

something we call the Power That Builds Reputations.



Peerless Electric





Moving-Scale Indicator Increases Reading Accuracy

The problem of parallax is eliminated, and reading accuracy is said to be increased with a new type of remote indicating device that consists of a moving strip scale behind a fixed horizontal hairline.

On the current model, the total scale length is 72 in., giving a reading accuracy of better than one part in 2,000, when scale divisions are $\frac{1}{8}$ in. apart. The 35-mm film scale can be calibrated in any units desired, with a maximum range of 5.5 to 1. The indicator can be located up to 2,000 feet from the primary instrument with no loss in accuracy, and at greater distances with special alignment.

The current model is designed for use with the model 54-OLX flow meter and Ratotronic transmission system made by this company. The transmission system is an electronic null-balance system, using a pair of soft iron armatures. The primary armature is positioned in the field of primary inductance coils by the action of the metering float. The motion of the primary armature unbalances an inductance bridge and this unbalance, transmitted through a phase-sensitive amplifier, causes the secondary armature located within the indicator case to be rebalanced by servo action. The instrument scale behind the fixed hairline is synchronized to the movement of the secondary armature.

The film scale and positioning servo-mechanism are mounted in a case 14 in. wide, 18 in. high, and 12 in. deep. Up to four scales may be installed in a single case, with all scales being geared to a common receiver. With this multiple arrangement, a circuit selector switch permits selection of four primary signals. Selection of any one primary circuit automatically illuminates the particular scale corresponding to the selected primary.

A voltage regulator in the 115 volt supply line eliminates voltage fluctuations. Temperature changes of ± 50 F from the design value of 70 F alter the electrical characteristics of the receiver of the indicating instrument less than ± 0.1 percent of full scale.

Fischer & Porter Co., 10 Jacksonville Rd., Hatboro, Pa.

A LOCKNUT that can be hot-dipped galvanized, does not require bolt tension to stay put, and can be removed and replaced any number of times without destroying its locking power. The locking insert is a slightly elliptical, heat-treated retainer ring. When the nut is applied, the bolt forces the retainer into the round, causing the retainer to grip the bolt. Sizes are from $\frac{3}{8}$ to $1\frac{3}{8}$ inches. The Security Locknut Corp., North Ave. & 15th Ave., Melrose Park, Ill.

THE NEW DESIGN OF A TORQUE WRENCH is said to differ from most conventional types in that: it is a torque-limiting device (releasing automatically at proper setting), and not a torque-indicating device (using dials, pointers, and scales); it uses a fully enclosed precision spring under compression as the principal torque-controlling element, it uses a micrometer type adjustment; and models with a built-in reversible ratchet head do the work of both a ratchet and torque wrench. Desired torque is set by turning the handle, just like a micrometer. When the right torque is reached by pulling the handle, the wrench releases and signals the operator with a reflex action. Upon removal of pressure, the torquer resets automatically for the next operation. Six models are available, three with ratchet head and three with plain head. Capacities are 5-75 or 10-150 ft-lbs. Drive sizes are $\frac{3}{8}$ or $\frac{1}{2}$ inch. Plomb Tool Co., Washington & Santa Fe, Los Angeles 54, Cal.

CONTINUED ON PAGE 248

CONTINENTAL'S PROOF BOOK

STEPHEN J. GROGAN

President of the Imperial Dinette Co. of Jersey City, N. J. Since starting the company five years ago, Mr. Grogan has built a high reputation and sales record as one of the leading producers in the dinette business today.

IMPERIAL DINETTE COMPANY, INC.

371 MERCER STREET • JERSEY CITY 2, N. J.

March 12, 1953

Continental Screw Company
New Bedford, Massachusetts

Gentlemen:

Your Hy-Pro Phillips insert bit, H-440-2, has proven itself through performance to be a gigantic production tool in our eyes. It has driven over one million 5/8 #7 Holtite Phillips Twinfast steel wood screws for us.

A while back we contacted various sources of supply to help us lick a production problem which was very common in our particular industry. Continental Screw Company worked with us to perfect this bit and screw, which are now serving our purpose so satisfactorily.

The screws are driven without any pilot hole through 1/8 inches of masonite and then into plywood to hold a steel table slide which supports the table top as it is opened and closed. There has never been a complaint of slippage, due to identical tolerances on both the bit and screw recess.

We do hope our relationship with you will continue to be as pleasant in the future as it has been in the past.

Very truly yours,
Stephen Grogan
Imperial Dinette Co., Inc.
Stephen Grogan, President

You too can count on Continental®

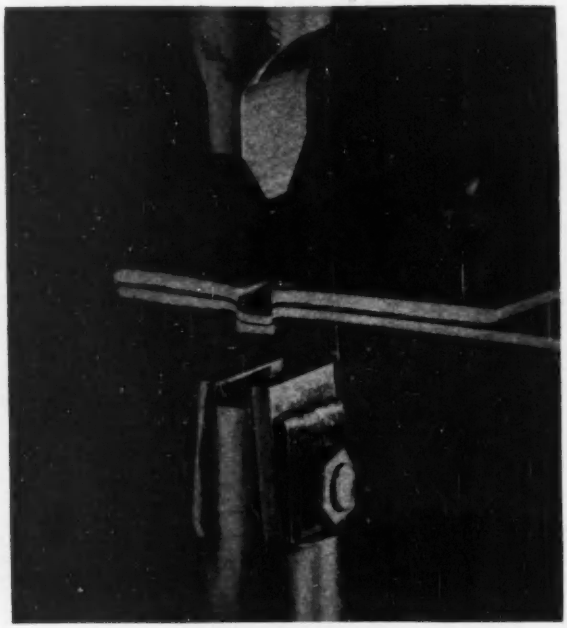
CONTINENTAL SCREW COMPANY INC. 1904

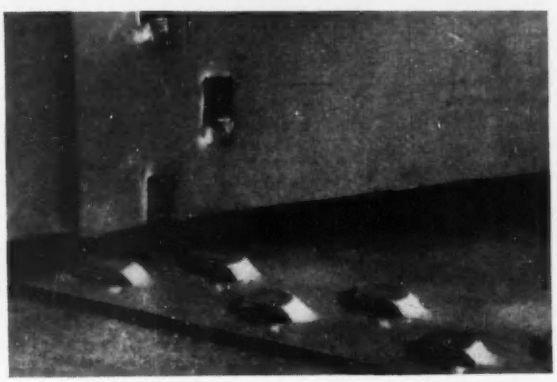
Hy-Pro Phillips Bit
#H-440-2 & Holder

Many similar reports of outstanding results from these bits are available to you. Call today for full details.

CONTINENTAL SCREW COMPANY, NEW BEDFORD, MASS., U.S.A.

Sheet Metal Fastened In One-Step Operation





By inserting a special punch and die, any punch press may be used in a new process known as Metalacing, which fastens sheet metal together without the use of rivets, bolts, welds or solder. The punch and yieldable die are made in a range of sizes that will fasten sheet metal up to $\frac{1}{4}$ in. thick in one operation.

The manufacturers claim that one of the features of the process is the reduction by almost one-half in the length of time required to do a job, because punching, drilling, alignment, and riveting are eliminated. The process will work with any material that can be sheared, drawn, and upset, and will fasten different metals together, such as steel and aluminum. Strength and holding qualities of metalacing are said to compare favorably with conventional rivets.

In operation, the impact of the punch on the metal and die results in a shearing action that makes a double incision in the two sheets of metal being fastened. The metal between these cuts is forced down between the die's movable jaws, with the force of the impact spreading the depressed metal sideways. This makes a permanent fastening wedge or button under the surface of the bottom sheet. The impression is rectangular in outline, which will prevent it from pivoting, and as the fastening has the same make-up as the parent metal, it may be sawed or re-worked.

Some applications are: pipe and duct manufacturing; sheet metal shops; truck, train, and airplane body plants; and heating and ventilating work.

Top and bottom views of the metalaces shown in the illustration at right, bottom are $\frac{1}{16}$ in. wide and $\frac{3}{16}$ in. long. The material is galvanized sheet steel $\frac{1}{32}$ in. thick. In the illustration at right, top is shown the punch and die, and a cross-section of the metalace. The material shown, magnified, is $\frac{1}{32}$ in. stainless steel.

Crockatt Engineering Co., Phelan Bldg., San Francisco, Calif.

Precision Slide-Wire Multi-Turn Potentiometer

A new slide-wire multi-turn potentiometer is now available in precision grades of ± 0.05 percent and ± 0.025 percent linearity, with both independent and zero based linearity ratings and closer rotational tolerances of plus one deg. and minus zero degrees.

Known as the model 85171A Spiralpot, its features include: infinite resolution; low operating noise level; a low starting torque of 0.6 oz.-in.; minimum inertia effects; and a long life of one million cycles, equivalent to 20 million rev. in a 10-turn unit.

It will operate in a temperature range of from —55 to —71C, has a stainless steel shaft rotating in ball bearings, and will operate with rotational shaft speeds up to 500 rpm. Syncro or threaded hole mounting, low capacitance and inductance effects, high insulation resistance and positive end stops are additional features of the unit. Diameter is 1.75 inches.

The spiralpot will operate under a steady state acceleration of 100 G's in any axis and will meet specifications under vibrations of 10 G's from 55 to 1,000 cps. Wattage dissipation at 25C is 5 watts, resistances of 2 ohms per turn, and 50 to 250 ohms per turn are available in from one to ten turn potentiometers.

In addition, a $1\frac{1}{8}$ in. dia. multiple-section potentiometer is available in assemblies of one to six sections with a six section unit requiring a torque of 0.6 oz.-in. Mechanical shaft rotation is 360 deg. continuous. Resistance values from 500 to 70,000 ohms per section are available. Each section will dissipate 2 watts at 25C.

G. M. Giannini & Co., Inc., 117 E. Colorado St., Pasadena 1, Calif.

CONTINUED ON PAGE 250

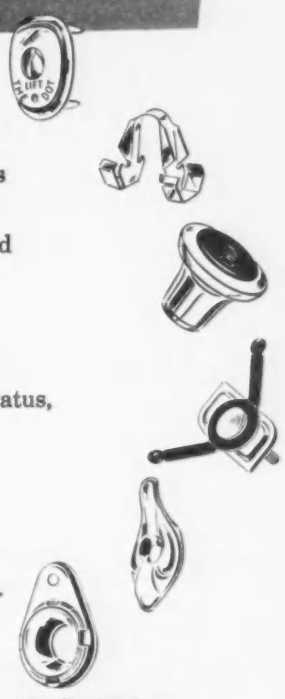
Special purpose fasteners by

CUT COSTS

SPEED ASSEMB

IMPROVE PRODU PERFORMAN

DOT



Give DOT the job of keeping your fastening methods up to scratch. A survey of your assembly operations may reveal costly fastener deficiencies that could be remedied simply by using special-purpose DOT fasteners specifically designed for their jobs.

With wide experience in the design and volume production of special fasteners for use in automobiles, aircraft, electronic apparatus, appliances, furniture . . . United-Carr's engineering staff is ideally equipped to serve you.

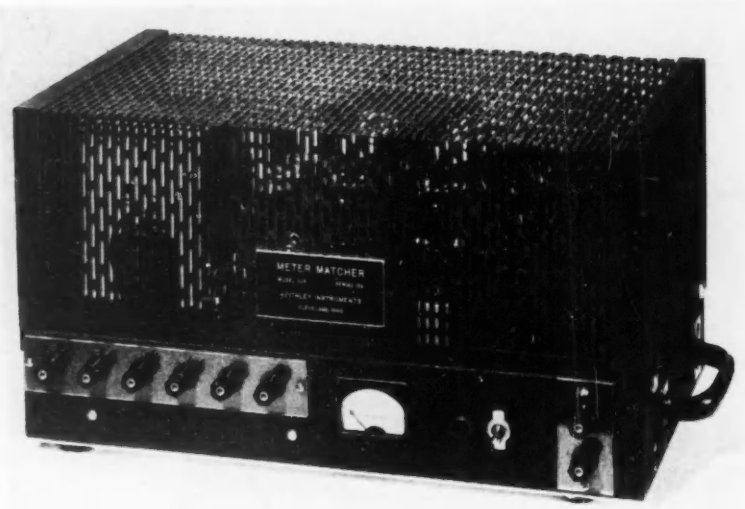
It is important, however, to call in United-Carr *before* your new designs are frozen for production. It is in the *planning* stage that you can make most effective use of our specialized services.

UNITED-CARR FASTENER CORP.

Cambridge 42, Massachusetts

MAKERS OF ***FASTENERS***

Measures Circuits Affected By Meter Currents



A new way to accurately test the secondary voltage of synchros and other circuits requiring meter current corrections has been made possible with the design of the model 105 Meter Matcher. This device is an accurate power frequency amplifier, which, when used, relieves the circuit being tested from supplying the usual power to the measuring voltmeter or wattmeter, almost eliminating the errors caused by meter currents.

In operation, the circuit to be tested is connected to the input of the meter matcher, and the output is connected to a voltmeter or the voltage coil of a wattmeter. The instrument's input current is 150 microamperes maximum, and its output supplies the 0.05 to 0.07 amp which most dynamometer instruments require for full scale deflection. The meter current, which in some cases is larger than the normal circuit current, is eliminated from the circuit which is under test.

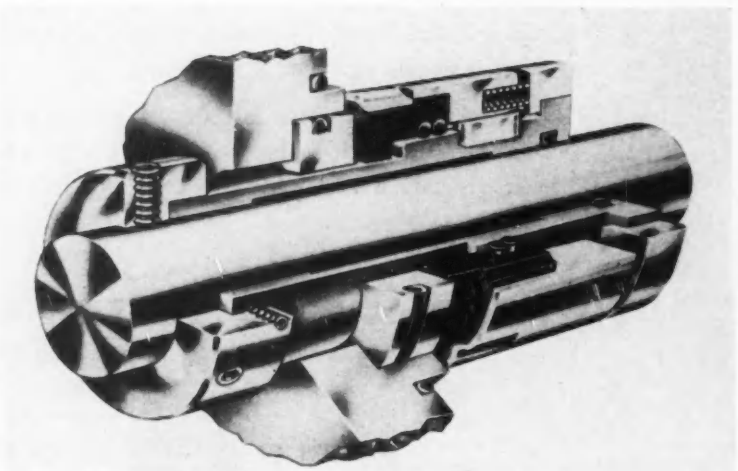
The device will develop 150 volts rms across a 2,000 ohm resistive meter load, and adds a 0.15 percent maximum error to the measurements. A large amount of negative feedback is used to reduce the effective output impedance to approximately one ohm in series with 15,000 microforads.

The output and input voltages are in phase except for the small displacement caused by the meter current in the internal impedance, about 0.006 deg for a 2,000 ohm resistive load. Connections for 15, 75, 150, 300, and 600 volt inputs are installed, with an output of 150 volts in each case, giving a 150 volts voltmeter or wattmeter an effective range of full-scale voltages from 15 volts to 600 volts.

Besides the testing of synchros, the amplifier has such uses as: measuring both linear and non-linear circuits when meter currents introduce errors not easily computed; increasing meter sensitivities; and a signal amplifier.

Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio

Heavy-Duty Type Balanced Mechanical Seal



Withstanding pressures up to 1,000 psi, a new heavy-duty mechanical seal has been designed so that it may be used in conventional stuffing boxes. A packaged unit, the seal is preassembled on a sleeve for installation.

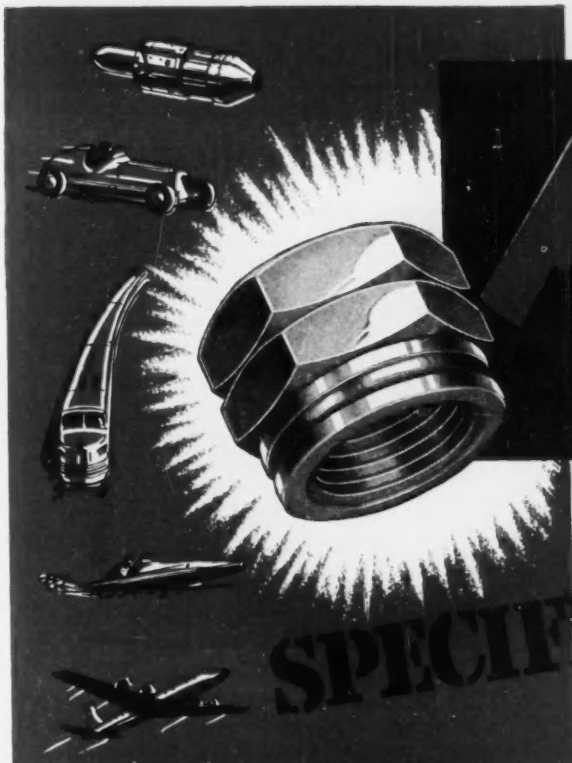
Using a rotating sealing washer and a floating stationary seat, balance is accomplished by lowering the washer face to a point where the stuffing box pressure is not exerted against the sealing area.

The rotating assembly consists of a retainer positively driven by the sleeve, with the washer driven from dents in the retainer. The assembly is held in contact with the lapped face of the seat by multiple springs around the sleeve at the back of the retainer.

Sealing between the sleeve and shaft, and between washer and sleeve is accomplished with O-rings.

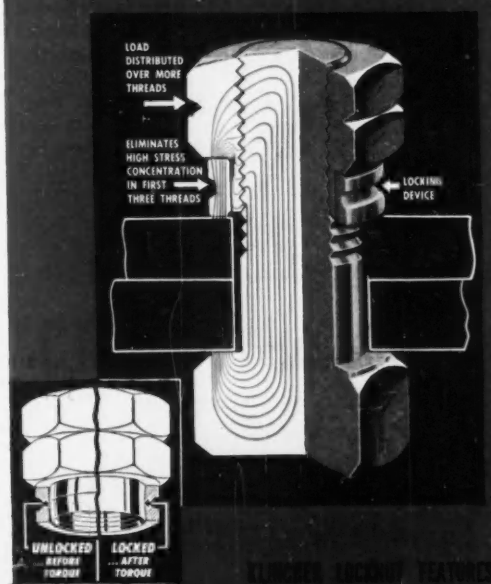
The Crane Packing Co., 1800 W. Cuyler Ave., Chicago 13, Ill.

CONTINUED ON PAGE 252



Klincher LOCKNUT

SPECIFIED { Wherever VIBRATION HIGH TEMPERATURE up to 1600° CORROSION TENSILE STRENGTH RE-USABILITY are factors!


LOAD DISTRIBUTED OVER MORE THREADS
ELIMINATES HIGH STRESS CONCENTRATION IN FIRST THREE THREADS
LOCKING DEVICE
UNLOCKED ... BEFORE TORQUE
LOCKED ... AFTER TORQUE

To meet the needs of designers for a single fastener combining all these stringent characteristics, Klincher Locknut was developed. Punishment meted out to bolt connections on today's jet and conventional aircraft engines, racing cars, Diesel engines and equally severe applications, demands a locknut like Klincher. Its one-piece handling offers many production-line and maintenance advantages.

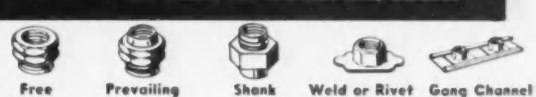
Inquiries invited regarding specialized locknut problems. Write for data and experimental samples, giving size and application.

KLINCHER LOCKNUT FEATURES

- Spins freely down to work. Starts positively locked.
- After breakaway, nut spins off-freely, ready for reuse, without impairment of locking efficiency.
- Only one piece to stock and handle . . . saves time installing and removing.
- Ideal for standard and power wrenches.
- Manufactured in stainless steel and other materials.

Klincher LOCKNUT CORP.
2153 HILLSIDE AVE. INDIANAPOLIS, INDIANA

INDUSTRIAL FASTENERS INSTITUTE



Free Running | Prevailing Torque | Shank Nut | Weld or Rivet Free Running | Gang Channel Free Running

National Fine and National Coarse Threads.

Miniature, Carbon-Film, Precision Potentiometer

Measuring $1\frac{3}{32}$ in. in diameter by $\frac{11}{16}$ in. in length, a carbon-film, precision potentiometer of infinite resolution will permit such continuous mathematical operations as the performance of sine-cosine, logarithmic, trigonometric, square and square-root functions without loss of resolution. The device weighs one ounce and is said to be the smallest potentiometer ever produced to permit such operations.

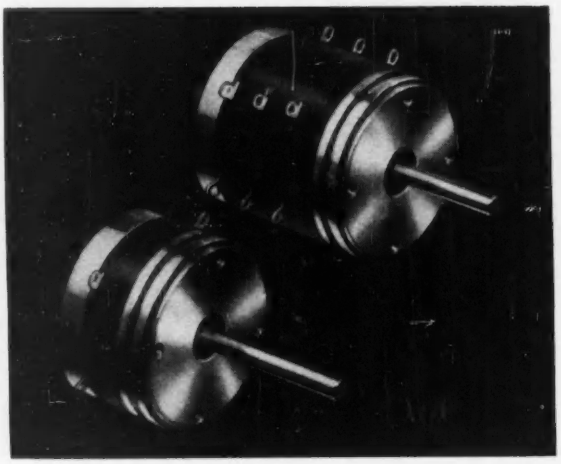
A new method of depositing the carbon film on the resistance element makes possible the infinite resolution of the potentiometer as well as a low noise-level performance.

A special internal trimming method results in increased accuracy for either linear or non-linear functions. Compensation for shunting effects from subsequent circuit elements is made possible by the non-linearizing of the resistance element of the loaded potentiometer so as to restore the potentiometer to the desired voltage ratio. This internal trimming operation is performed at the time of manufacture to meet the loading conditions. It often makes it possible to eliminate isolating or coupling amplifiers. Taps can also be used without changing the local voltage ratio.

Either single or multiple assemblies of the potentiometer are available. In ganged assemblies, nested units on a common shaft have no backlash and a minimum increase in starting torque and shaft run-out. Each additional circuit increases the length of the potentiometer by $\frac{1}{4}$ inch.

This type 105 potentiometer may be used with torque amplifiers, gyro pick-offs, and similar problems of low energy capabilities. It is also suited for use in severe ambient temperatures. Its low torque permits long life and operations at high speeds.

The standard mounting arrangements of the potentiometer 105 are of the synchro type. Different mounting features and pigtail terminal arrangements are available.



The model 105 potentiometer is shown in the illustration in two versions. The smaller version incorporates a single type 105 resistance element, and measures $\frac{11}{16}$ in. in length, not including the shaft. The other unit, which has three resistance elements, shows how in ganged assemblies, each additional circuit increases the length of the potentiometer by $\frac{1}{4}$ inch.

Precision depositing of a carbon film has also been applied to translation potentiometers and special mechanical shapes for potentiometers and disks for RF attenuation applications have been designed.

Micromax Co., 1964 Utica Ave., Brooklyn, N. Y.

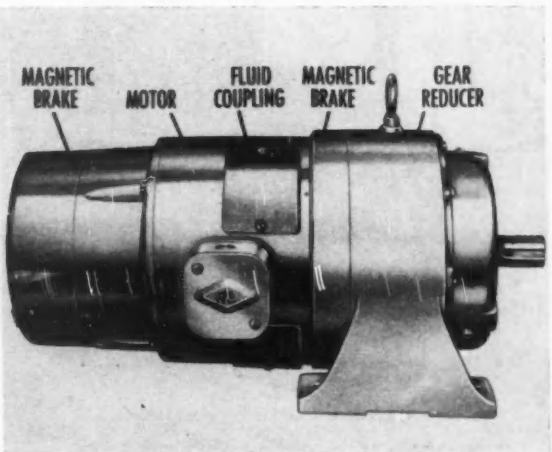
Combination Fluid-Shaft Motor, Brake, and Drive

Consisting of: a magnetic brake; a motor with an internal fluid coupling; a second magnetic brake; and a gear reducer, a new fluid-shaft Motoreducer is able to give fluid-cushioned stops, as well as starts, with the added advantage of a holding brake.

One of the applications is with a crane travel drive. Its use here is in eliminating the pendulum motion of the load through smooth acceleration and deceleration, yet permitting a stationary holding action at any point.

In this example, the operating sequence is as follows: (1) the energized motor transmits power to the load through the fluid coupling; (2) after travel, the load is decelerated through the fluid coupling by the magnetic brake mounted on armature; (3) at this point, the load can be held stationary by application of second brake mounted between coupling and gear reducer. If desired, this latter brake can also be used for braking when the load is still in motion.

Additional combinations of fluid-shaft motors, brakes and drives, in a wide range of hp and rpm ratings, are available to handle specific load requirements.



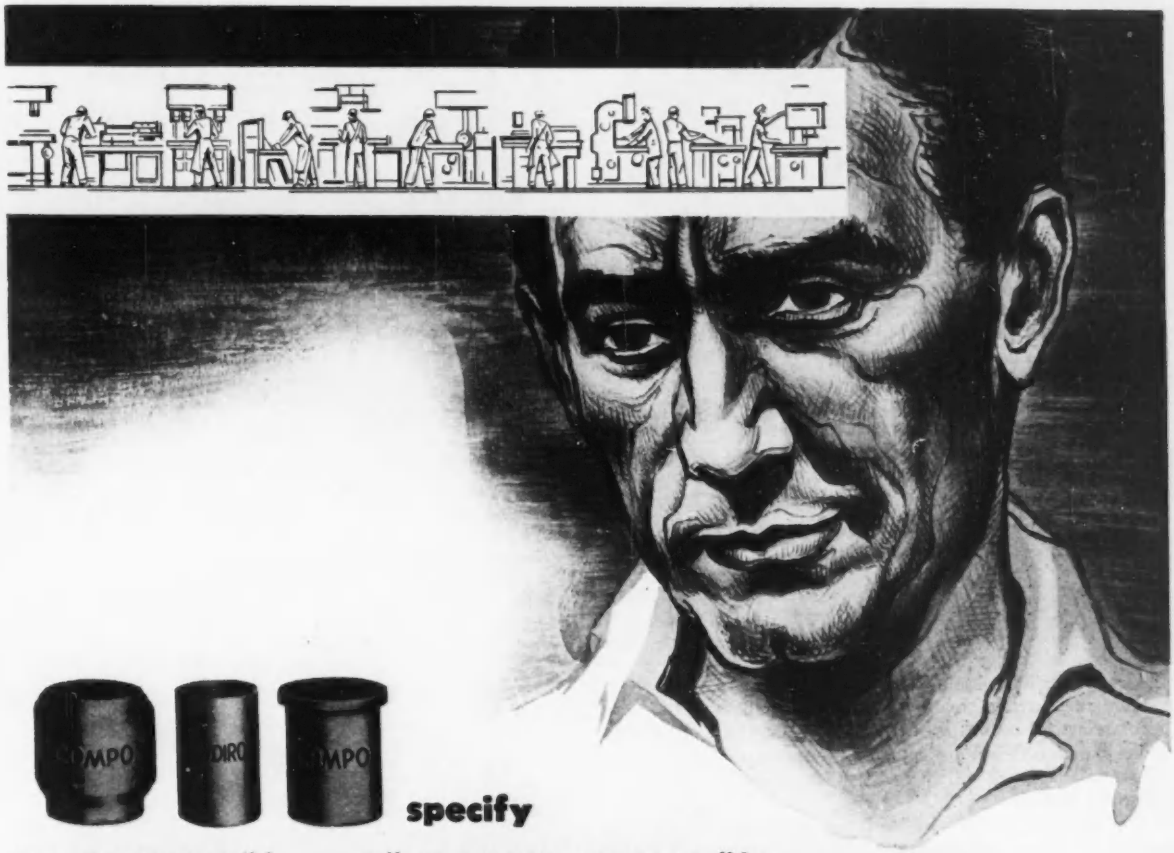
Reuland Electric Co., Alhambra, Calif.

CONTINUED ON PAGE 254

"Where'll I get the OPERATORS for 12 reams per unit?"

No wonder your shop squawks, these days, about every job that calls for skilled operators:

What can **you** do about it—**without** sacrificing product quality? Well, you can



specify

"COMPO"® and "POWDIRON"® bearings

(porous bronze) (sintered iron)

They need no reaming! A simple press fit sizes them to accurate as-installed I.D.

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OIL-LESS BEARING COMPANY

Bound Brook, N. J. **Bound Brook 9-0441**
MANUFACTURERS OF BEARINGS AND PARTS • ESTABLISHED 1883

Oil-Actuated Clutch Needs No Adjustment

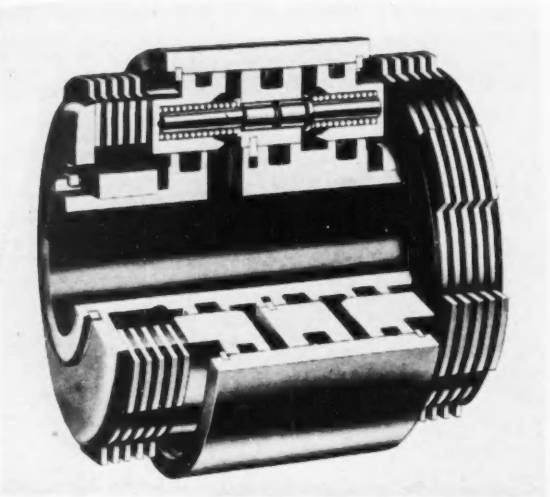
Available in single and duplex models, a new oil-actuated multiple plate clutch has been designed with such features as: no-adjustment; higher, more constant torque capacity; more compactness; adaptability to remote control; longer wear life; and snap rings for easy disassembly.

The new clutch design is based on the generally standardized type of mechanically actuated clutch, incorporating an integral oil cylinder to clamp the plate stack.

The main feature of the clutch is that no adjustment is required to compensate for friction plate wear, since the floating or pressure plate is the ram of the cylinder. As the plate stack wears, the ram travel increases automatically.

Also, the torque capacity of the clutch for any given oil pressure is always constant, permitting the use of a smaller clutch. The design of the clutch permits the torque capacity to be directly proportional to the applied oil pressure, since this pressure creates the clamping force.

The manufacturers claim that compared with the conventional mechanically actuated clutch, the oil-actuated design has other advantages where remote control is desired. The new clutch design needs only a selector valve and a seal, as compared to the conventional throwout fork, operating shaft, hand lever, and a means to grease the throwout collar.



Twin Disc Clutch Co., Racine, Wisc.

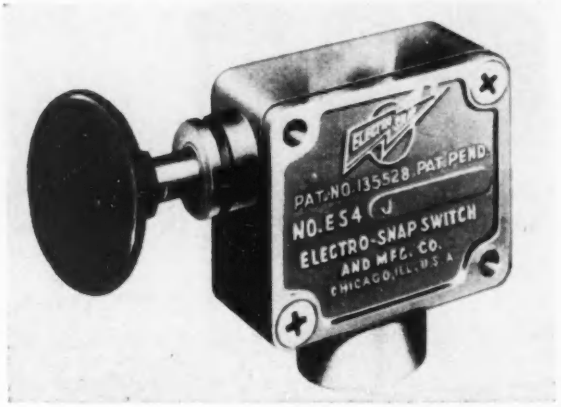
Small Limit Switch Has High Electrical Rating

An industrial limit switch designed to make possible more inexpensive circuit controls by minimizing the need for relays in automatic sequencing or interlock operations, has a die-cast case and integral plunger-type actuator, and is available with either constant or one-way momentary contact action.

The switch, type ES4-J, with the constant contact action, completes a circuit as the switch is actuated, and breaks the circuit as the actuating force is removed. When actuated, the one-way momentary contact model sends an electrical impulse, and then opens the circuit for the rest of the plunger's forward movement. The switch is not tripped as the plunger returns to its original position.

The switch has an electrical rating of 10 amps at 125 v a-c and long life; and is available with a single-pole, double-throw circuit arrangement only. Mounting is versatile, and the switch is wired into a circuit through a standard industrial conduit connection. Clearance dimensions, including knob actuator and conduit connector are $3\frac{3}{8}$ in. x $2\frac{5}{8}$ in. x $1\frac{3}{4}$ inches. Its small size and adaptable mounting makes for convenient location.

The switch is also recommended for use as a safety device. With two switches of this type connected as interlock switches in the control circuit of a punch press, the worker must depress both switches with his hands before the press will operate.



Electro-Snap Switch & Mfg. Co., 4218 West Lake St., Chicago 24, Ill.

SERIES E PRECISION RESISTORS are non-inductively wound on nonhygroscopic ceramic bobbins with resistance wire having a low temperature coefficient. Units with resistances of over 800 ohms are wound with Evanohm alloy, and those under 800 ohms are wound with Manganin. Both alloys produce low thermal E.M.F. against copper. Standard tolerance is one percent, with tolerances up to 0.05 percent also available. Standard temperature coefficient is 0.000025 per degree C. The Hycor Co., 11423 Vanowen St., North Hollywood, Calif.

CONTINUED ON PAGE 256

ROASTERS

TYPE R thermostats give clean, positive make and break of circuit. Also used in range warming compartments, low-wattage water heaters, and electronic devices requiring a high degree of temperature control.

IRONS

TYPE S thermostats feature clean, positive make and break. Electrically independent bimetal prevents artificial cycling for longer thermostat life. Available in adjustable and non-adjustable styles precalibrated for your product.

STEVENS

STEVENS

STEVENS thermostats make appliances perform better—longer

REFRIGERATORS

TYPE W thermostats give *snap-action* make or break on temperature rise. Used widely in butter-warming compartments, electronic devices, rectifier fans, and apparatus requiring sensitive, precise control of high-wattage heater loads.

PERCOLATORS

TYPE M thermostats have bimetal disc that gives quick make and break in appliance, apparatus and electronic applications where close control and compactness are essential. Open, hermetically sealed, or neoprene-protected styles for severe dampness.

STEVENS

STEVENS

Stevens makes the largest line of bimetal thermostats in the industry—several hundred styles in all. So even if you have an unusual design problem, check with Stevens first. Probably a standard Stevens thermostat will fill the bill for specifications, price and delivery—and at the same time insure the performance and life of your product. A-5617

STEVENS

manufacturing company, inc. MANSFIELD, OHIO

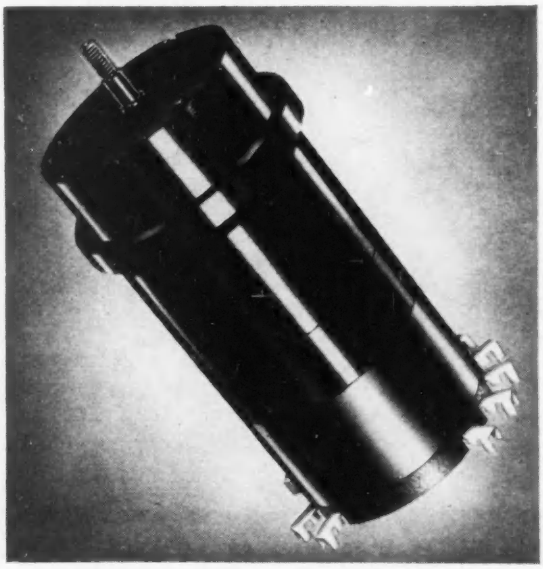
Electrical Resolvers For Computing Systems

Composed of a resolver, a hi-gain amplifier, and a summing network box, a new electrical resolver system for use in computers and computing systems is capable of operating with accuracy over a wide environmental range.

The network box combines its inputs for introduction into the hi-gain amplifier; the amplifier feeds the resolver, either the basic resolver or the vector solver type; and the outputs of the resolver are the desired functions.

This resolver system operates accurately at temperatures from —60 to +160 F; and is standardized to permit interchangeability without upsetting the system. Flexibility is made possible through a choice of network boxes and amplifiers.

Specifications for the size 31 and 23 resolver systems are: frequency 400 ±5 cps max; input voltage, 0.25—12.0 max; input impedance, 1.0 megohm; transformation ratio (at 8.0 volts input), 1.0000/0 deg 0 min; variation of transformation ratio with input voltage from 0.25 v—12.0 v, ±0.06 percent for size 31 system, ±0.1 percent for size 23 system; variation of transformation ratio with change in temperature (—60 to +160 F), ±0.05 percent for size 31 system, ±0.1 percent for size 23 system; maximum error of sine value during 360 deg rotor rotation (any one input voltage), ±0.00060 for size 31 system, ±0.00070 for size 23 system; max. error of cosine during 360 deg rotor rotation (any one input voltage) ±0.00100.



Ford Instrument Co.,
31-10 *Thomson Ave., Long Island City* 1, *N. Y.*

Pressure-Operated Manually Reset Valves

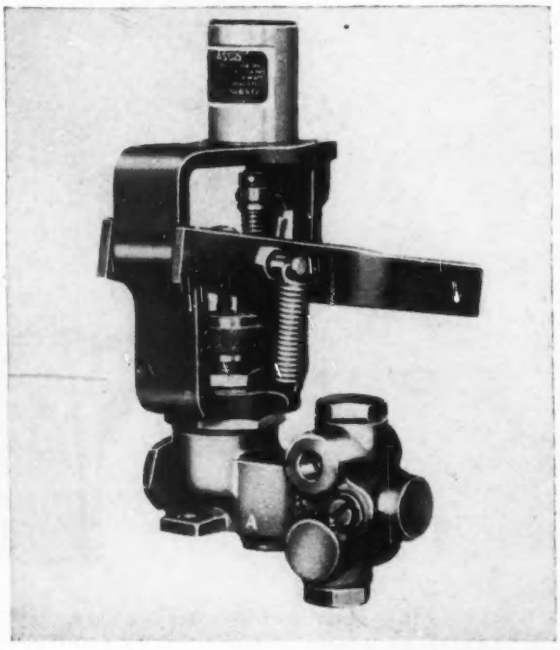
Used where hazardous locations prohibit electrical connections, a new pressure-operated, manually reset valve has been designed for application in oil refineries, gas plants of all types, and other plants.

This model 8035 valve is available in two, three, and four-way construction, operates on loss or application of pressure, and requires no electrical power.

The two-way model comes in bronze, cast-iron, steel, and stainless steel for water, air, chemicals, oil, steam, and corrosive liquids and gases with sizes ranging from ⅜ to 6 inches. Maximum temperatures: bronze, 350 F; cast-iron, 450 F; steel or stainless steel, 600 F. Maximum pressures range from 600 psi for the ⅜ in., to 5 psi for the 6 in. valves. Standard normally closed valves are manually opened and trip closed upon loss of pressure; optional design is to trip closed upon application of pressure.

The three-way valve is furnished in ¼ through ½ in. pipe sizes in bronze, cast iron, steel, or stainless steel for air, water, chemicals, oil, steam and corrosive liquids and gases. Maximum pressures: 500 psi for the ¼ in. and 150 psi for the ½ in. size. Metal or resilient type seats are used.

The four-way valve sizes range from ¼ to ¾ in. all bronze construction. Valves are suitable for pressures up to 250 psi and temperatures up to 300 F. Suitable for control of air, water, oil, and non-corrosive gases and liquids. Valves can be furnished with auxiliary switches for indicating lights and electrical control circuits. For special applications where electrical connections are permissible, these valves can be used with a pilot solenoid valve.



Automatic Switch Co., 385 *Lakeside Ave., Orange, N. J.*

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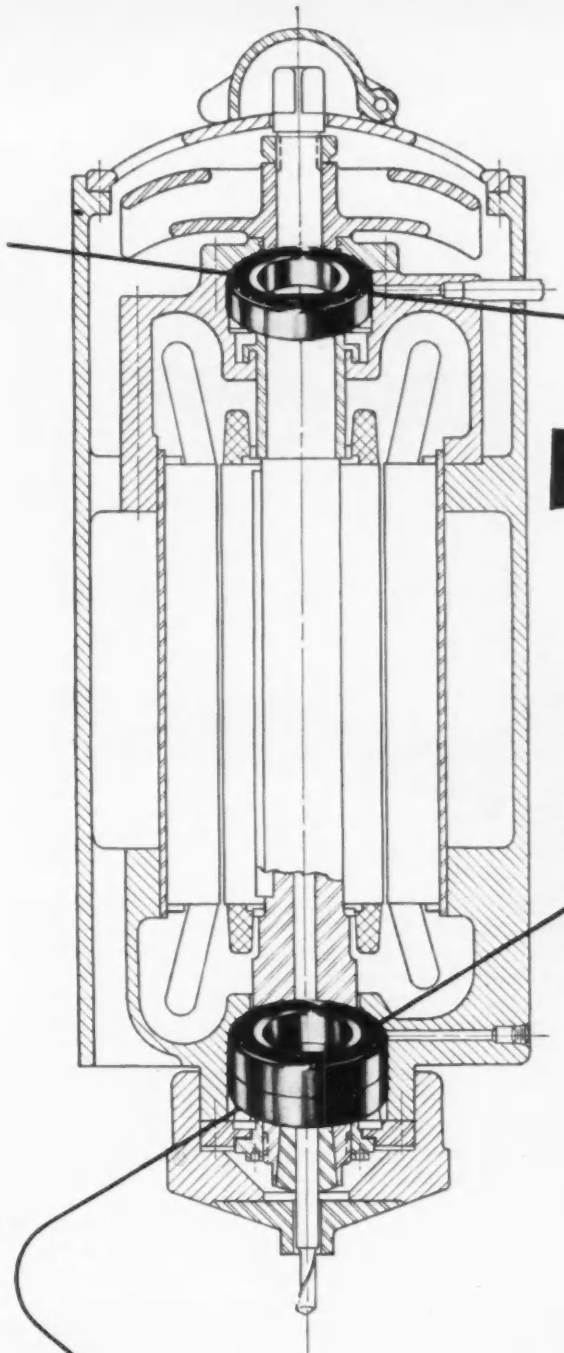
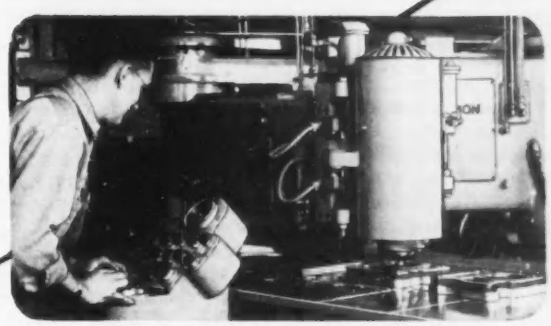


LOOKS SIMPLE

WAIT TILL YOU HEAR WHAT IT DOES!



High-speed, remote controlled router made by Ekstrom, Carlson & Company, Rockford, Illinois.

You guessed it. This is a blueprint of a spindle head. It shows the arrangement of Fafnir Super-Precision Ball Bearings . . . a single bearing at the top duplexed bearings at the work end.
What's unusual about it? Listen to this . . .

The spindle head is part of an Ekstrom, Carlson high-speed, remote-controlled machine that template routes through 1-inch aluminum plate with a single pass and at cutting speeds as high as 90 inches per minute. It is driven by a 30 h.p. variable speed motor and operates up to 15,000 r.p.m. The radial load on the bearings is as high as 500 to 600 pounds. The spindle head takes tool bits with diameters from 5/16" to 3/4".

Although the top design achievement of this new machine tool is its electrically-controlled hydraulic feed mechanism, the spindle bearing application is no ordinary accomplishment. Fafnir engineers worked hand-in-hand with Ekstrom, Carlson engineers to make it successful. Another example of the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designers' viewpoint, an aptitude for supplying the right bearing to fit the need. The Fafnir Bearing Co., New Britain, Conn.

FAFNIR

BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

Graph Data Converted Into Electrical Impulses

The Logrinc digital graph follower shown consists of a combination of the digital plotter and the necessary photo-electric and electronic components for automatically following curves and converting the data into electrical impulses. The unit serves as a combination input and output device for digital computing equipment, in addition to other uses.

Working as an output device, it will plot any two variables against one another, each electrical impulse received causing an incremental movement of the pen. As a follower, it will handle any continuous function, including those which have infinite slopes.

The follower has two general modes of operation. It will either follow the curve at a maximum rate and deliver electrical impulses corresponding to incremental movements on both axis, or it will allow motion on one axis to be externally controlled. In this latter operation, incremental changes along one axis are fed from an external source, and the automatic follower produces electrical impulses to correspond with resulting motion on the other axis.

The follower may be used as an input and output device for digital differential analyzers. With a digital computer, the follower may be used as an input or output device for any general purpose digital computer which can be coded to accept or deliver incremental information. Used in conjunction with the necessary counting and holding circuitry, the device will plot curves from punched cards or tape, or will make up cards or tape from a given curve.

Operating as a follower and accepting motion on one axis as an input, delivering corresponding motion on the other axis as an output, the device can replace entire subroutines for generating desired functions in digital computing systems. And when used with an additional Logrinc plotting drum, it can digitally transmit empirical curves by wire or radio.

Also, the plotting drum may be equipped with sprocket drive which will enable the follower to plot or follow continuous curves of indefinite length. Even without the sprocket drive, curves of some length may be handled by allowing the paper to wind up several layers on the drum.

The follower will give digital output information to an accuracy within the smallest increment of the plotter. The two increments usually used in the plotter are 1/100 or $\frac{1}{64}$ inch.

Curve Requirements: With the digital graph follower, any line down to approximately 1/100 inch in width may be followed, but the line must be dark in color. The follower can be set to ignore grid lines provided there is sufficient contrast in intensity between the grid lines and the curve to be followed.

Logistics Research, Inc.,
141 South Pacific Ave., Redondo Beach, Calif.

Small Quantity Fluid Flow Control

A purge rotameter, designed for use where small, flow meters are needed to indicate and manually control small flows of fluids with good reproducibility, has a flow control valve that gives sensitive control of fluid through the meter over the entire flow range at differential pressures between 1 to 100 psi across the control valve.

Typical applications include the indication of: flow of supply air in bubbler type liquid level measuring installations; flow of purge fluid, generally water or air, in the pipelines connecting orifices, venturi tubes, or nozzles to differential head flow meters; flow of transparent purge fluid to slight glass indicators of rotameters measuring the flow of opaque fluids; flow of sample fluid to measuring installation for continuous chemical analysis of fluids.

Purge rotameters are small size variable area type flow meters for low flow ranges. The rate of flow of the fluid passing through the meter is indicated by the position of a ball float moving in the tapered glass meter tube vertically installed in the meter. The rate of flow is read in reference to the center of the ball float on a scale mounted alongside of the meter tube.

A back flow check valve prevents back flow of process fluid into the purged apparatus if the pressure of the process fluid should exceed that of the purge fluid, or if the meter tube is removed from the meter body. The meter is suitable for mounting on instrument panels and in larger instrument cases. They must be installed in a vertical position, and can be installed directly in pipelines, on instrument panels or in instrument cases. A one-piece meter body protects the glass meter tube.

Schutte & Koerting Co.,
Cornwall Heights, Bucks County, Pa.

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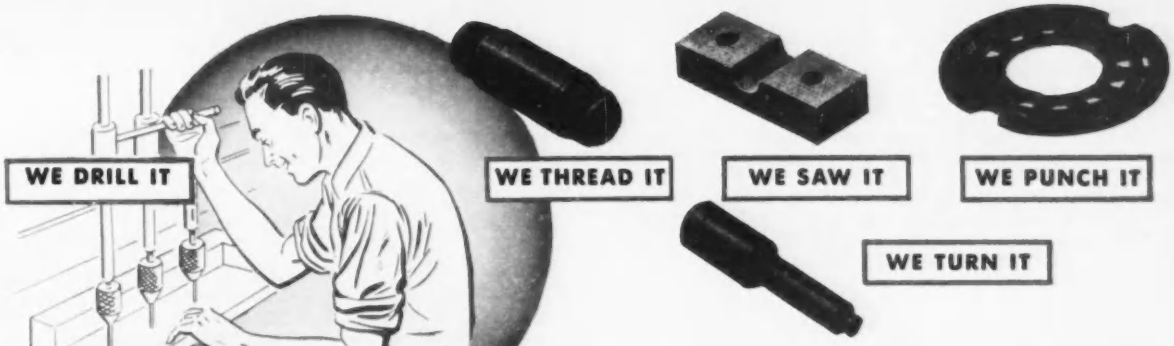

MACHINABILITY... one of many important properties found in combination in Spaulding Fibre products

Products in the Spaulding line display a unique array of electrical, mechanical and chemical property combinations which give them almost unlimited versatility.

Machinability, for instance, may be obtained in combination with one or more of the following properties: electrical insulation, arc resistance, deionizing properties, structural strength, resistance to wear and abrasion, good forming, light weight and chemical inertness.

This versatility accounts for the fact that the parts we fabricate from Spaulding basic materials are found in everything from washing machines to welding equipment, from radios to railroad cars.

To find out how Spaulding products may contribute greater efficiency to your own product without extra cost, or do the same or a more efficient job at lower cost, mail the coupon for the Spaulding handbook or consult your nearest Branch Sales Office.

SPAULDING PRODUCTS FOR INDUSTRY

VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.

ARMITE: Thin insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.

SPAULDITE: (Laminated Phenolic Plastic) in sheets, rods, tubes and fabricated parts.

SPAULDO: Motor Insulation in sheets, rolls, coils, slot cells and other fabricated parts.

SPAULDING FIBRE BOARD: In sheets and fabricated parts.

SPAULDING T BOARD: A superior Transformer Board, in sheets and fabricated parts.

MATERIALS HANDLING EQUIPMENT: Factory trucks, Boxes, Barrels, Trays, etc.

SPAULDING FABRICATING FACILITIES

Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation to you.

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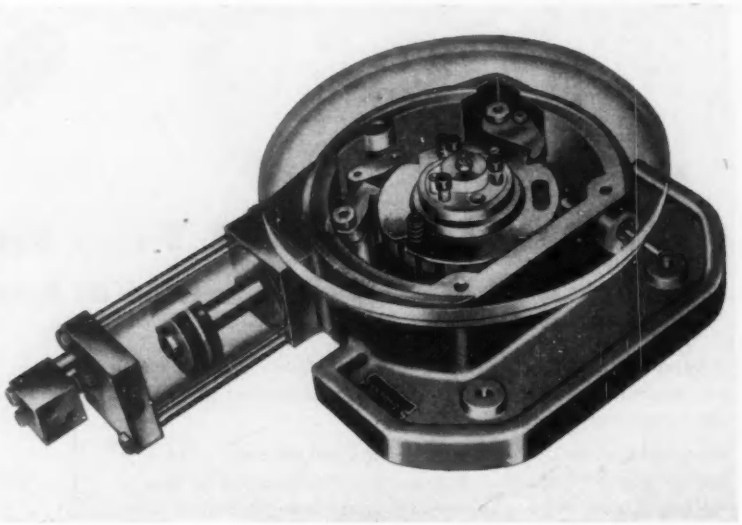
PE

Dial Feed Table With Positive Lock

New model dial feed tables having a positive lock feature are available in the standard 4-6-8-12 and 24 set of indexing positions. The feature of this table is that the top plate cannot override and lose index under severe conditions of operations. This is accomplished by use of an auxiliary air cylinder built inside the table whose function is to bring into a toggling position, a set of mechanical members which lock the feed pawl to the ratchet.

A hydraulic check is offered as an accessory and gives a controllable shock absorbing effect at the end of every index stroke requiring smooth operation. Accuracy of the indexing is said to be ±0.002 measured at the periphery of the 11 inch top plate.

Two models are available, 11 FA and 11 FB. Model FB is identical to model FA except for a two-way valve and a pilot timer valve to make the table operate fully automatically.

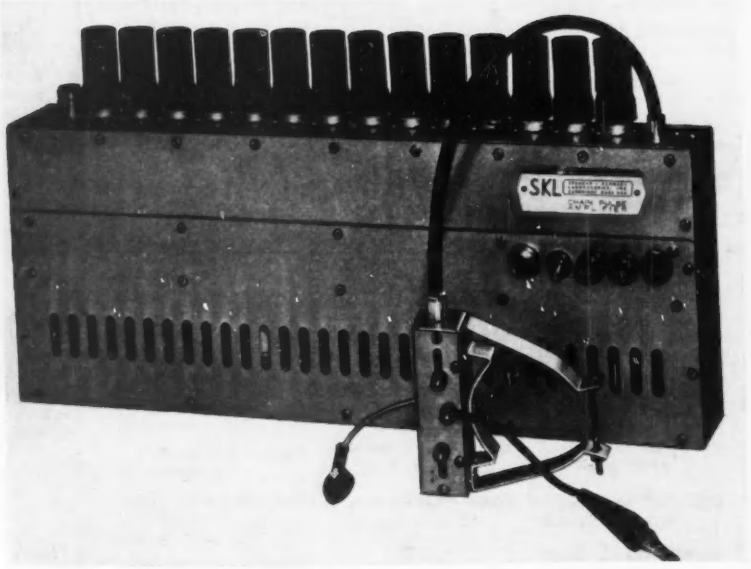


A. K. Allen Co., 57 Meserole Ave., Brooklyn 22, N. Y.

Chain Pulse Amplifier Has Greater Bandwidth

Greater bandwidth, fast rise time without overshoot, and high output voltage are some of the features of the new model 214B chain pulse amplifier. Fourteen 6AH6 tubes are used to obtain the maximum output voltage of 125 volts over a bandwidth of 200 cps to 90 mc. The amplifier has a pulse gain of 30 decibels and a rise time of better than 0.006 microseconds. The frequency response is flat within 1½ db from 500 cps to 80 mc. Its phase response is linear within the pass band.

The output connection is at the end of the coaxial cable and is designed to fit the neck of a cathode ray tube or be connected to other equipment without alteration or special connectors. Two output impedances are available: 500 ohms and 5,000 ohms. The 180 ohm input impedance is designed to approximately match the impedances of the model 202P wide band chain amplifier, a number of which may be used as preamplifiers to the model 214B when more gain is required.



The fast rise time, and stability of the 214B make it useful in the study of fast pulses in radar, nuclear radiation, television, and UHF research. Because it has good signal noise to ratio, it may be used in narrow band as well as broad band application. Its design shields the amplifier and stabilized power supply, and may be placed beside a cathode ray tube when used in the construction of a broad-band oscilloscope or synchroscope.

Spencer-Kennedy Labs, Inc., 186 Massachusetts Ave., Cambridge 39, Mass.

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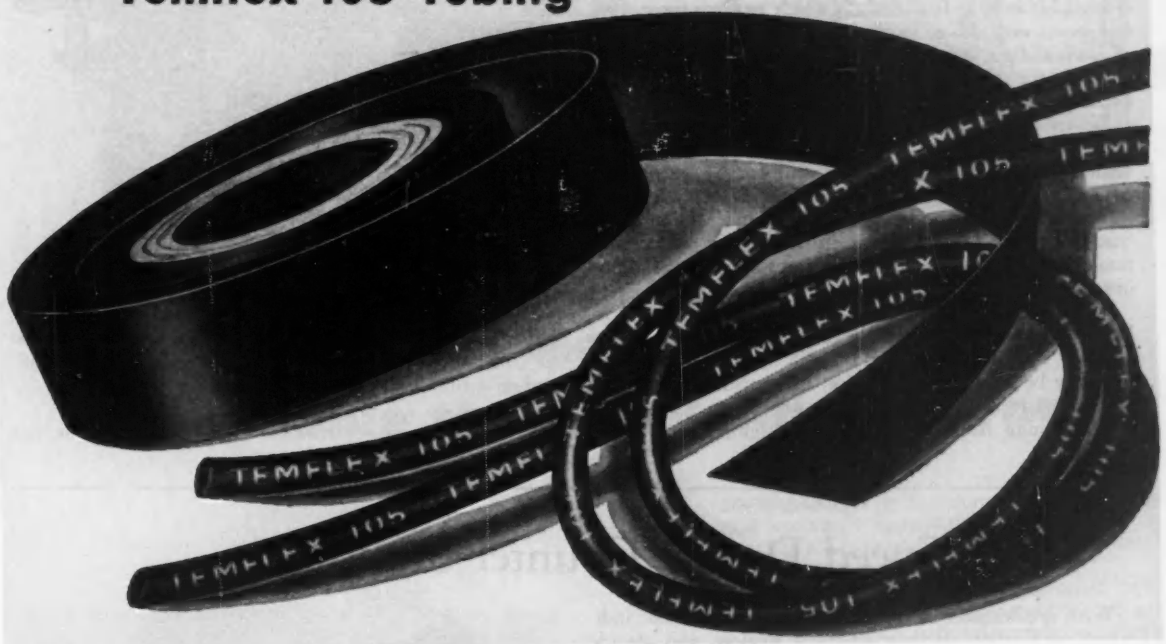
Now— an Irvington PLASTIC INSULATING TAPE with the heat- and oil-resistance of Temflex® 105 Tubing



Here is a new addition to the Irvington family of insulating tapes — Temflex 105 Plastic Tape, based on the *same* formula that has made Temflex 105 Tubing the leader where service calls for continuous operation in air at 105° C. — or in oil at 90° C.

Temflex 105 Tape is strong and flexible — possesses exceptional elongation. It can be easily hand wound over bus bars, coils, cables — even over very irregular surfaces — or can be used in taping heads. Temflex 105 Tape frequently offers substantial savings as compared with varnished cambric. Easily baked to a homogeneous mass, it also offers cost economies over pressure-sensitive tapes.

Made in thicknesses of .007", .010" and .012"; widths from ½" to 34". Dielectric strength as high as 1200 vpm *even at 100° C.* Tensile strengths up to 3100 psi — elongation 165% to 240%.

Look to **IRVINGTON** for Insulation Leadership

INSULATING VARNISHES
VARNISHED CAMBRIC
VARNISHED PAPER
VARNISHED FIBERGLAS
INSULATING TUBING
CLASS "H" INSULATION

You probably know Temflex 105 *Tubing* — you'll certainly want to learn about Temflex 105 *Tape*. Mail the coupon for technical data sheet.

Send this convenient coupon now

Irvington

VARNISH & INSULATOR COMPANY

10 Argyle Terrace, Irvington 11, New Jersey

Plants: Irvington, N. J.; Monrovia, Calif.; Hamilton, Ontario, Canada

Irvington Varnish & Insulator Company PE 6/53
10 Argyle Terrace, Irvington 11, New Jersey

Gentlemen:

Please send me technical data sheet on your new Temflex 105 Tape.

Name..... Title.....

Company.....

Street.....

City..... Zone..... State.....

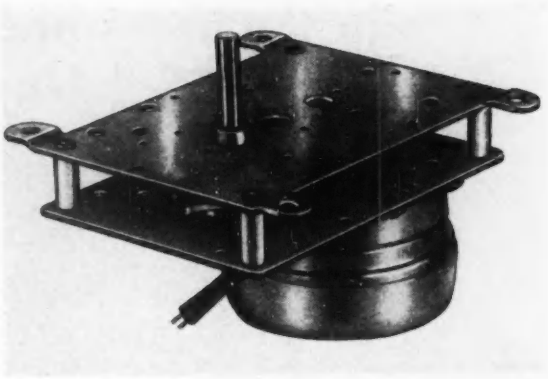
Positive Lock In Stop-and-Go Timing Machine

The intermittent motion in this machine is made possible by a new gear design which produces constant speed throughout the motion, but which has a positive lock when it is not in motion. Called the "Stop-N-Go", this machine is available now in four designs which produce three, four, five, or six stop-and-go motions per revolution. The number of stop-and-go intervals desired are determined by the speed of the motor. With the wide range of motor speeds available, almost any timing cycle is possible.

When in operation, the total period of immobility is twice the time taken for motion. For example: in a ten second cycle the machine stands still for 6⅔ sec, and in 3⅓ sec it moves to the next stop. In a 6 sec cycle, 4 sec "stop" and two seconds "go". The manufacturer claims that there is no perceptible lag in the motion. Its resumption of full turning speed between stops is said to be almost instantaneous.

The overall size of this machine is approximately 3¼ in. by 2 inches. Power of the drive motor is 8 in.-oz at one rpm. It operates on 110 and 220 v with 3 watts input, and may be used in any position in temperatures ranging from —40 to +140 degrees Fahrenheit.

The timing device was designed originally for use in rotating tables to give a definite rest period of the display, but is now being adapted for use in controlling the motion of color spot wheels and for use in controlling the off-and-on action with miniature precision switches.



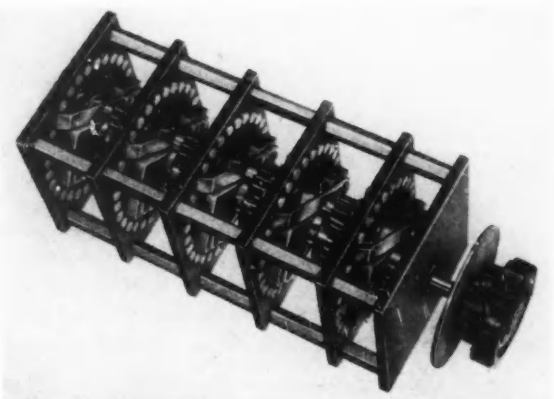
Hansen Mfg. Co., Inc., Princeton, Ind.

High Speed Decade Counter Switch

With applications in computers, recorders, remote indicators, and other electro-mechanical devices, this decade counter switch has been designed particularly for work requiring an indication of shaft position at a remote point, and for the switching of one circuit after the complete rotation or switch cycling of another circuit.

The special switch contact panels are modified so that the rotor arm makes electrical contact every tenth revolution of the input shaft. The first section makes 10 revolutions for one revolution of the second section, and in turn requires 10 revolutions to one of the third section, and so on. Five contact panel decades are arranged through a series of intermittent gear reduction mechanisms, giving a total of 99,999 switch positions.

The operation of this unit is analogous to that of a visual counter indicator, except that electrical contact is used in place of each digit seen on the scale of the number wheels. The device features high speed operations up to 500 rpm; 1,000 v d-c insulation; and silver alloy contacts and rotors.



The Daven Co., 191 Central Ave., Newark 4, N. J.

A CARTRIDGE TYPE PRESSURE RELIEF VALVE, which is insensitive to back pressure or system pressure, has been designed primarily for aircraft use, but which also has other industrial applications. The valve operates so that it is not a bias across the line, and eliminate the effects of system or back pressure so that relief pressure stays constant over a wide range of back pressure. The use of the valve in aircraft has made possible the design of a self-positioning wing flap system. Pantex Mfg. Co., 521 Roosevelt Ave., Pawtucket, R. I.

A RECIRCULATING VALVE that may be used for any stream dividing application of gases, air, salt water, oil, and mild chemicals to 125 psi, is said to be leakproof, and has reduced handle loads and internal wear due to an externally adjustable spring seating control featuring multiple ball pressure contact against hardened wear rings. Ardee Mfg. Co., 840 N. Seward St., Los Angeles 38, Calif.

CONTINUED ON PAGE 264

Which

makes Adlake Mercury Relays more dependable than conventional types?

"Mighty Midget" ADLAKE Relay Contact normally open or closed.

DEPENDABILITY is the sum of many things... and ADLAKE's dependability is built on engineering skill, exhaustive testing, and quality construction features like these:

Positive leak-proof sealing—assured by the use of properly selected metals and glass components with properly matched thermal expansion characteristics.

Arc-resisting ceramics—ceramics with great temperature-resistance are used to reduce any destructive effect caused by the arc.

Liquid, mercury-to-mercury contacts—completely eliminates failures caused by low contact pressure, contact burning, pitting and sticking—and the inherent high surface tension of mercury imparts an ideal snap action to the contacts.

Yes—as thousands of enthusiastic users in every branch of industry know—ADLAKE means dependability every way! Write for your free copy of the ADLAKE Relay Catalog today... The Adams & Westlake Company, 1169 N. Michigan, Elkhart, Indiana. In Canada write: Powerlite Devices, Limited, of Toronto.

Every ADLAKE Relay is tested—*and guaranteed*—to meet specifications!

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

Adlake 96th year of serving the transportation and building industries

Portable Industrial X-Ray Units

Available for quick set-up in the shop or laboratory, the 175 kvp portable X-ray unit shown at left in the illustration is capable of radiographing steel parts and welds having thickness up to 2 inches. The 120 kvp unit has a limit of $\frac{7}{8}$ inch.

A feature of the Fedrex X-ray unit is the combining of the x-ray tube and all other high tension parts in one tank. A complete unit consists of two parts: the x-ray tank containing the x-ray tube, high voltage transformer, filament transformer, and cooling pump; and a control panel with instruments, regulating devices, exposure timer, and safety relays. Separate transformers, cooling pumps and connections have been eliminated.

The x-ray unit can stand vertically, hang in the eye bolts, or be placed on any support. Portable stands on wheels are also available. The design of the equipment permits outdoor operation regardless of weather conditions.

There is a selector switch for the various supply voltages of 110, 220 or 440 volts; a compensating device for deviations in supply voltage; and continuous regulation of high-tension and tube current.

The kv range (continuous regulation) for model 175 is 45-175 kv, and for the model 120, from 30-120 kv; the mA range (continuous regulation) for both is 1-5 mA; focal spot is $3\frac{1}{2}$ mm for the 175, and $2\frac{1}{4}$ mm for the 120. Covered film area in relation to focus-film distance (D) is 0.7 D for both units. Weight of the model 175 is 180 lb, and model 120 weighs 130 pounds.

Holger Andreasen, Inc., 703 Market St., San Francisco, Calif.

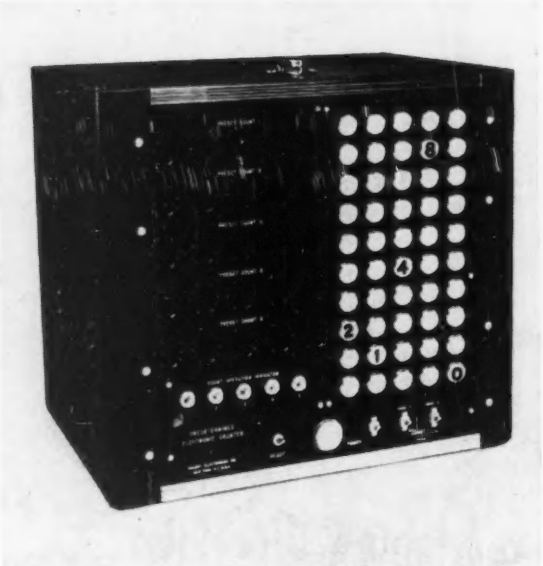
Cold Cathode Tube Design In High Speed Counters

High speed predetermined electronic counters using an all cold cathode tube design, are able to produce output information on illuminated numerals for direct panel readouts without any interpolations or additions for any digit. Requiring no warm-up time, these counters are able to operate at any selected count for application to machines or processes requiring the measurements and control of frequency, quantity, length, time, velocity and revolution. They are available for single, dual or multiple sequencing.

Using cold cathode TT-1 counting tubes which do not require either filament transformer or high voltage power supply, there is no danger of continual tube burnouts and failure.

Preset decimal counting decades have been designed so that each counter tube functions as a direct readout number, while predetermined counts are selected by dial switches on the facing panel. When the predetermined number of counts has been registered, the unit actuates a control relay whose action may be utilized to perform any given function. The counter is able to reset automatically without loss of a single count, while recycling may be either manual or automatic.

The counters are built with various outputs as well as input circuits and are available in different predetermined count capacities. Designs on the new counter are limited to ten digits and six sequential preset count settings.



Haledy Electronics Co., 57 William St., New York 5, N. Y.

CONTINUED ON PAGE 266

Nothing like it for writing piping specs

...Your Complete CRANE Catalog

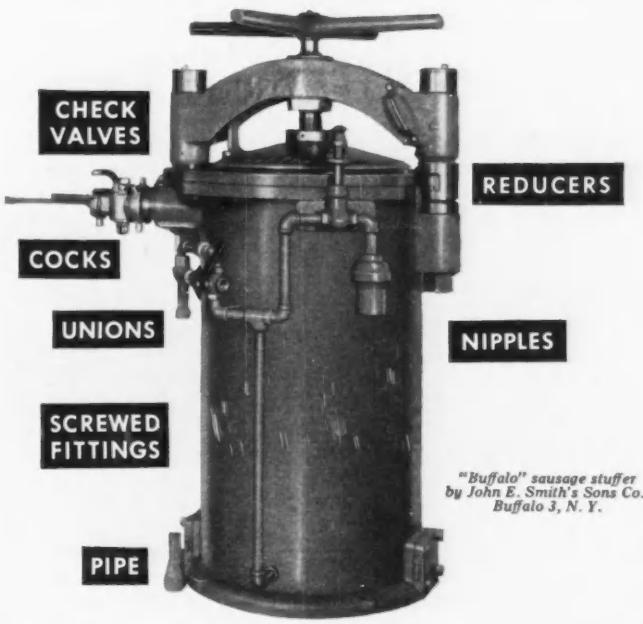
The reason is simply this: Your Crane Catalog lists the world's most complete selection of quality piping equipment. And it's completely indexed—3 ways—and arranged to save you time. Along with clearly stated pressure-temperature ratings, you get all essential size and dimensional data—plus details on design, materials and construction. In addition, your Crane Catalog contains a full separate section of basic engineering information for your ready reference.

That's how Crane makes writing piping specs easier for you. But designers long in the business know the bigger advantage to be gained in specifying Crane equipment. And that's the advantage of known quality and proved dependability—assuring bigger value down the line to the ultimate customer.

CRANE QUALITY BRASS COCKS

. . . Widely preferred for their smooth operation and positive closure. Big selection in the 125-Pound Class—two, three and four-way; square, flat and tee head; with and without check. Sizes up to 2-inch. Also available—extra-strong 250-pound cock of Crane Special Bronze. Two-way pattern with square head only. Sizes up to 2-inch.

NOTHING LIKE CRANE QUALITY EQUIPMENT FOR ADDING TO DESIGN VALUE



"Buffalo" sausage stuffer by John E. Smith's Sons Co., Buffalo 3, N. Y.

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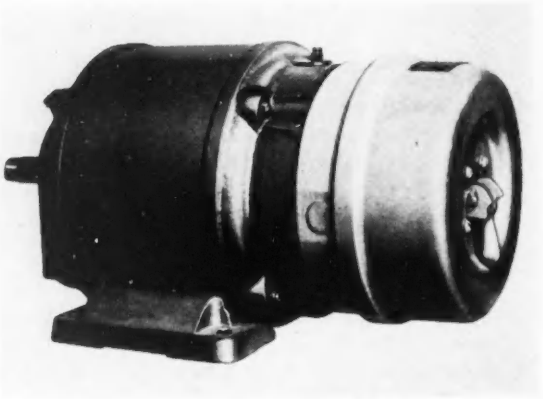
Direct Acting Disk Type Magnetic Brakes

Fractional horsepower magnetic brakes for all standard a-c or d-c electric motors are now available with ratings of $1\frac{1}{2}$, 3, and 5 lb-ft torque. Typical applications are: machine tools, hoists, cranes, elevators, screwdowns, and where automatic, controlled braking is required. The brakes are spring engaged and magnetically released, and are designed to mount on NEMA type C motor flanges.

In operation, the motor and brake are connected in parallel. Starting the motor simultaneously energizes the magnet coils. The magnet attracts the armatures which are attached to the pressure plate, compressing the springs and releasing the pressure on the disks. Stopping the motor de-energizes the coils. Spring tension then forces the pressure plate back, applying steady pressure to the disks, to stop the motor quickly while holding the load.

The magnetic brakes self-adjust for wear, but critical adjustment of torque can be made for precisely timed stops. Units have thermal ratings of 6, 7, and 8 hp seconds per min, respectively, and molded asbestos friction disks with high heat dissipation keep the operation cool. The design does not require solenoids and mechanical linkages. All brakes are equipped with a hand release, and mount without dismantling the brake or disturbing the torque setting.



The brake mechanism is housed in a cast aluminum cover with a cast iron mounting bracket. The standard brakes are fully enclosed and are drip-proof and weather-proof.

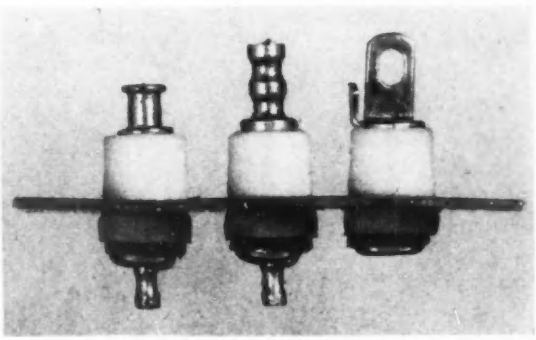
Dings Brakes, Inc., 4740 W. Electric Ave., Milwaukee, Wisc.

Easily Mounted Miniature Hermetic Terminals

Miniature, hermetic terminals of teflon and silicone rubber for improved performance and simplified construction are mounted in holes with a minimum center distance of $\frac{15}{64}$ in., and still have wiring space after the assembly.

These terminals are designed for operation at a rating of 500 volts, with a test voltage of 1,500 volts rms. The current rating is 8 amperes.

The terminals have passed cycling tests under MIL-T-27 military specifications. Depending upon the type of electrode, the assembly is accomplished by clinching in a press with jigging, or by a drive fit of the electrode with a press. The hermetic seal is completed by soldering at the time leads are attached. The series #199 terminals are available in three electrode styles: hollow electrode with eyelet for minimum internal clearance; solid electrode with single turret; and solid electrode with double turret.



Lundey Associates, 694 Main St., Waltham 54, Mass.

MECHANICALLY OPERATED CONTROL VALVES for follow-up booster type positioning systems are available in a variety of horsepower and flow ranges for system pressures up to 3000 psi. The valves feature linear flow output and precision adjustment of piston land and sleeve port spacing for optimum neutral position characteristics. Valves can be supplied for either manifold mounting or threaded for pipe or AN tubing fittings. Nitralloy moving parts are used for long service life and smoothness of operation. In applications where small forces are available to actuate the valve, as when cams are driven by low power motors, valves may be obtained in which normal stroking forces have been reduced so that only light spring forces are required to maintain the piston in contact with the driving cam. Hydraulic Controls Co., 87 Terrace St., Roxbury 20, Mass.

NEW VIBRATION ISOLATORS are so designed that the load-bearing spring returns the damper to its normal position on every cycle. This reduces the loss of efficiency due to damper packing of wire-mesh units after a period of service. Known as type 7630 and 7640, they are JAN cup-size 1 and 2. Other features are light weight, high isolation efficiency, and wide temperature tolerance. The Barry Corp., 700 Pleasant St., Watertown 72, Mass.

CONTINUED ON PAGE 268

PUMPS

for Home, Defense & Industry!

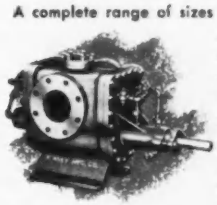
What do you need . . . Hydraulic controls for a bomber, a helicopter, a guided missile or for a machine tool, piece of construction equipment, lift truck or paper machine? A better water supply for your home or pumps for an entire irrigation project? Or, perhaps, you need high vacuum pumping facilities or a pump that will handle paraffin, tar or syrup. Whatever it may be, you'll find pretty close to an ideal answer here . . .

HYDRECO GEAR TYPE PUMPS

Reversible and non-reversible. Gear type pumps in exclusive FOUR-BOLT design . . . capacities from .5 to 130 gpm and operating pressures to 1500 psi . . . flange or foot mounted . . . furnished with keyed shaft with spline shafts optional. Also dual and tandem models.

KINNEY LIQUID HANDLING PUMPS

A complete range of sizes in Rotating Plunger and Herringbone Gear Pumps to handle light or heavy liquids, sludges, slurries or viscous substances. Available in plain or steam jacketed models and built of special corrosion resistant metals where desired.



KINNEY VACUUM PUMPS

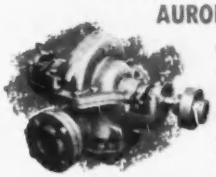
Single stage models to produce absolute pressure readings of 10 microns (.01 mm Hg.) . . . compound pumps producing readings of .2 microns (.0002 mm Hg.) or better. These Kinney High Vacuum Pumps are available in sizes for laboratory as well as high production use.

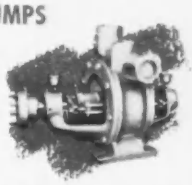
DUDCO DUAL VANE TYPE PUMPS

DUDCO Pumps provide a broad range of sizes with capacities to 120 gpm and pressures to 2000 psi. Also available in multiple units operating from a single drive. Hydraulic motors with starting torque outputs to 14,000 lb. in. at 2000 psi.

AURORA CENTRIFUGAL & TURBINE PUMPS

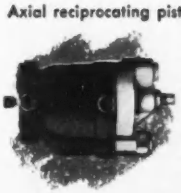
Deep well, sump, drainage and condensation return units, household water systems. Industrial low and high pressure liquid handling pumps. Direct motor and countershaft driven horizontal and vertical models. Capacities 3 to 7500 gpm.





STRATOPOWER PISTON TYPE PUMPS

Axial reciprocating piston type . . . constant or variable delivery with capacities of .25 to 10 gpm at nominal speeds of 1500 rpm with maximum of 4500 rpm . . . working pressures to 3000 psi . . . direct engine and individual electric motor driven models.



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Write—

For detailed information on the type of pump in which you are interested.

THE NEW YORK AIR BRAKE COMPANY
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Gentlemen: Kindly send additional information on the pumps I have checked.

- ☐ Hydreco Pumps
- ☐ Kinney Liquid Handling Pumps
- ☐ Stratopower Pumps
- ☐ Kinney Vacuum Pumps
- ☐ Dudco Pumps
- ☐ Aurora Pumps

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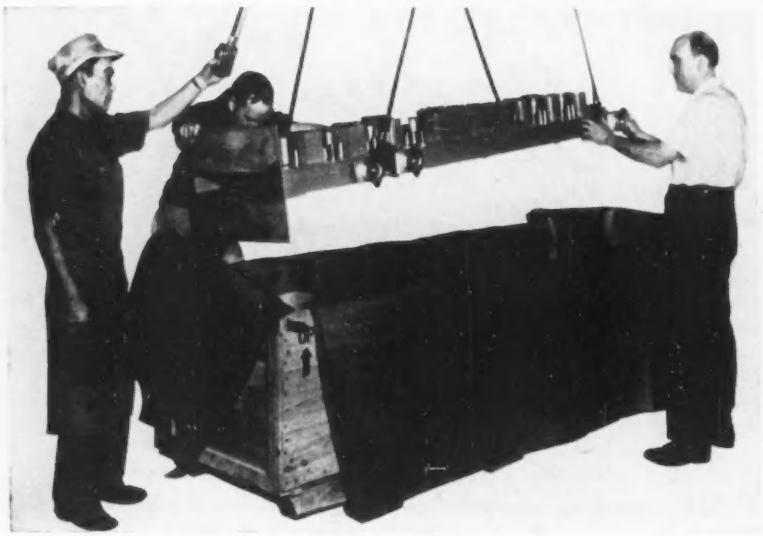
Protect Your Product

with Barrymounts



Photograph courtesy of PHILCO CORPORATION, Government and Industrial Division

The problem of protecting delicate equipment in transit is enormously simplified by properly designed shock mounts *built right into the packaging*. Barry shock mounts, designed for protection against the severest shocks of military service, have demonstrated their value in this industrial application.

Philco Corporation has made Barrymounts standard in packaging design for the entire Philco Microwave Program, and has shipped thousands of microwave equipments all over the world without the slightest damage. Philco microwave equipment is shipped *pre-assembled*, with all the tubes, glass dessicators, and crystals in place. On arrival, the only work required is powering the equipment.

Barrymounts are the modern method of shock protection. Let them simplify *your* packaging problems. Write today for more detailed information.

THE **BARRY** CORP.

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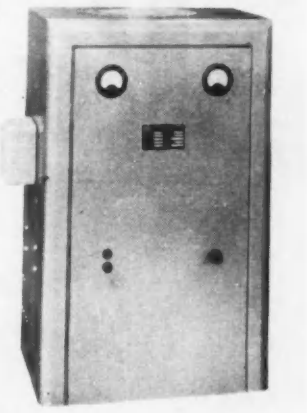

Precision Power Supply For Computers

A new high power d-c supply source with a range from 6 to 500 v d-c, and from 5 to 200 amp has been designed especially for the requirements of digital and analogue computers, business machines, and other electronic devices.

The unit has a dynamic regulation of better than 0.2 percent with wide load and alternating current line changes. Steady state regulation is less than 0.15 percent from no load to full load, with ±10 percent a-c line voltage. R M S ripple can be filtered as low as 0.01 percent, with 0.5 percent as standard.

No moving parts or electronic power tubes are used, and the magnetic amplifier—selenium rectifier design eliminates thyratrons or ignitrons. Because of its 75 percent efficiency, the unit has sufficiently cool operation to reduce refrigeration requirements in office-installed computers.

Inet, Inc., 8655 South Main St., Los Angeles 3, Calif.

Small Size, Wide Range, Temperature Control

A small size temperature control suitable for laboratories, low temperature ovens, heating and air conditioning between the limits of ±300 F operates on the principle of differential expansion of solids, and includes such features: as snap-action electrical contacts, cast aluminum waterproof housing, easy temperature adjustability, and close operating differentials.

The temperature sensing element consists of a high expanding outer tube and a low expanding inner member. The relative motions of these,

2-stage performance in single stage regulator

with Norgren Cylinder Gas Regulators

- Norgren 1-stage Cylinder Gas Regulators are specially built to regulate the pressure of cylinder gases, from tank supply to point of use, as accurately as most 2-stage types. Outstanding features include close control of delivery pressure, positive delivery without "creep," and exclusive ball-pivoting lower spring rest which assures permanently friction-free operation.

- Maximum primary pressure of 3000 psi. Maximum working pressures of 100 psi., 175 psi., and 450 psi.

Adaptable for use on following gases:

CARBON DIOXIDE
NITROUS OXIDE
NITROUS OXIDE AND CARBON DIOXIDE MIXTURES
OXYGEN, MEDICAL
CARBON MONOXIDE
ETHANE
ETHYLENE (INDUSTRIAL)
(MEDICAL)
HYDROGEN
METHANE

Water Pumped:

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ARGON
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Write for COMPLETE DATA ON REGULATORS AND ACCESSORIES

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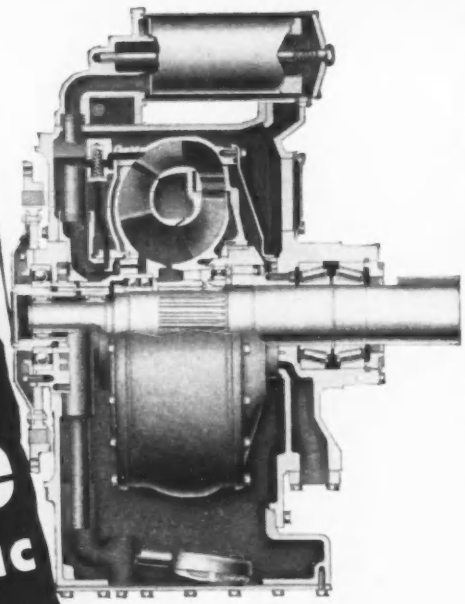
NEW

TWIN DISC

Two-Stage HYDRAULIC TORQUE CONVERTER



Filling the gap in industrial hydraulic drives, Twin Disc offers the first of a new series of Two-Stage Hydraulic Torque Converters — providing maximum operational efficiency, *up-to-4:1 torque multiplication at stall* combined with *progressively* increasing engine speed during acceleration or *uniform* pull-down under load. This new series features complete unloading of the engine at high-speed, no-load conditions, providing economy and minimum cooling requirements.

This new concept in Two-Stage Converters—developed in close cooperation with leading engine and equipment manufacturers — is backed by the same engineering and service reputation that has already made Twin Disc the acknowledged world leader in the development of Industrial Three-Stage Hydraulic Torque Converters.

If you are using powered equipment needing a Torque Converter Drive — and for which the modified performance characteristics indicated are desirable—write for specific information on the new Two-Stage Torque Converter Series. Address all inquiries to Twin Disc Hydraulic Division, Rockford, Illinois.

Typical Twin Disc Two-Stage Hydraulic Torque Converter, Model SD (shown above), with Spider Drive and Disconnecting feature.

Built for a Long Life . . .
Backed for a Lifetime

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

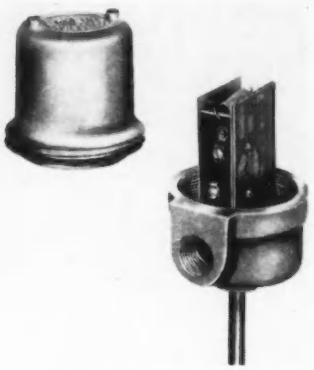
TWIN DISC CLUTCH COMPANY, Racine, Wisconsin · HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND · DALLAS · DETROIT · LOS ANGELES · NEWARK · NEW ORLEANS · SEATTLE · TULSA

caused by temperature changes, is multiplied by a lever which actuates a small precision switch. A dial graduated 1 to 10, and an adjusting screw with pointer and a locking set screw, are used for changing the temperature settings.

A waterproof housing of cast aluminum gives full protection. For wiring there is a $\frac{1}{2}$ IPS hole in the side of the lower half of the housing.

Standard tube lengths are 5, 10 and 15 in., with the 10 in. length recommended for most applications. With the tube of brass and of this length, an operating differential of plus or minus $\frac{1}{2}$ F can be obtained in most installations. The longer and shorter tubes will decrease or increase this proportionally. Standard tube diam-



eters are $\frac{3}{8}$ in. and $\frac{1}{2}$ in. O.D. Fittings for mounting the instruments are available with the $\frac{3}{8}$ in O.D. tubes.

The precision switch has snap-acting contacts rated for 15 amp 125-250-460 v, 60-cycles, a-c. Any one of three switch actions may be used normally closed (opens on temperature rise); normally open (closes on temperature rise) or single pole double throw.

Burling Instrument Co., 5 Vose Ave., South Orange, N. J.

Variable Speed Small Electric Impulse Motor

Featuring low speed without gears, and pin-point stoppage when the current is cut off, this small electric impulse motor with variable speeds is made entirely of steel and has a vernier adjustment speed control.

Called the Vibramotor, the unit is suitable for any application where reciprocating and rotating elements must stop dead at predetermined points. In the animated display field it eliminates solenoid mechanisms and permits use of multiple pistons, resulting in many movements on one display. Other uses

New

PERMANENT MAGNET DESIGN RESULTS IN A DOUBLE-BARRELED SAVINGS!

FOR TOP ENGINEERING COUNSEL ON PERMANENT MAGNETS CONSULT INDIANA

DESIGN SUMMARY

Equipment
Telephone pay station manufactured by Automatic Electric Company, Chicago.

Application
Polarized coin return relay.

Situation
Automatic Electric previously used a chrome steel magnet. Automatic Electric and INDIANA engineers worked together in redesigning the permanent magnet assembly used in the polarized coin return relay, switching to the use of Alnico III material.

Results
1) An increase in flux of 27%—from 2750 Maxwells with old chrome steel magnet to 3500 Maxwells with Alnico III. 2) 70% Savings in cost of permanent magnet. 3) Saving in weight. 4) Simplified design and assembly. 5) Fewer service calls needed since, with the new design, a positive mechanical coin return action was secured—*permanently!*

To help you with your permanent magnet design problems, write for Design Manual No. 4-C6.

. . Double-barreled Savings!

- **Lower first cost—70% saving**
- **Positive mechanical action—fewer service calls needed**

This is another example of how INDIANA's top engineering "know-how," secured from experience gained in successfully solving the design needs of over 35,000 permanent magnet applications, resulted in an improved product design.

You, too, can look to INDIANA for quality permanent magnets—for skill in manufacture—for cost cutting engineering aid. Rigorous quality control in every step of production is your assurance of exact magnetic and mechanical characteristics.

INDIANA is the only manufacturer furnishing all commercial grades of permanent magnet alloys. Furthermore, it has the ability and facilities to develop and produce the permanent magnets you require on a regular production schedule. For help with your problem, write INDIANA, today.

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA
World's Largest Manufacturer of Permanent Magnets

INDIANA PERMANENT MAGNETS

PERMANENT MAGNETS MAY DO IT BETTER

Here's how 13 Twin City Castings prove LUCKY in this SCOTCH BRAND Tape dispenser

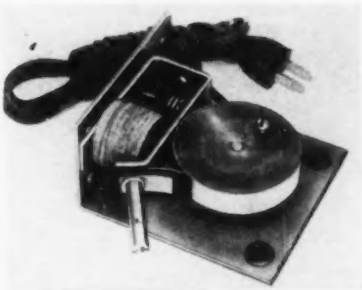
13 TWIN CITY CASTINGS USED IN TYPE "M" BOX SEALER

Here was a job that called for *more* than accurate dies and close-tolerance castings. It called for *co-operation* between designer and die caster . . . the kind of cooperation so important to creative manufacture.

Result: an extremely successful manually operated box sealer for use with Scotch brand cellophane tape. The unit is built by Specialty Manufacturing Company for Minnesota Mining and Manufacturing Co., manufacturers of Scotch tape. The dispenser contains 13 zinc die castings from complex main frame to small trip-pin arm . . . all *Twin City* die castings and *Twin City*-built dies.

If you have a particular die casting job, large or small, that calls for "cooperation" with your die caster . . . contact Twin City. Hundreds of manufacturers have found that it pays.

TWIN CITY DIE CASTINGS CO.
3350 TALMAGE AVENUE S. E. · MINNEAPOLIS 14, MINN.



include mechanical toys, games, agitators, chemical and laboratory apparatus, alarm systems, electrical controls and similar applications.

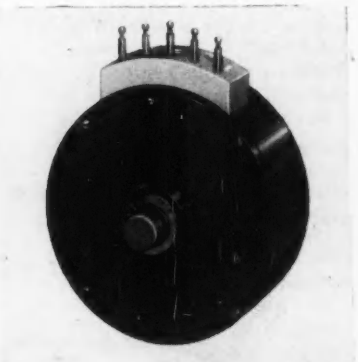
Model AV with a variable range of one to 250 rpm has a net weight of 1½ pounds. Dimensions are 2 x 4 x 5¼ inches. The vibramotor is also available geared, reducing speed to a range of ½ rpm to 80 rpm with increased power. Operation is 110 v a-c, 60 cycle only.

General Die & Stamping Co., 262 Mott St., New York 12, N. Y.

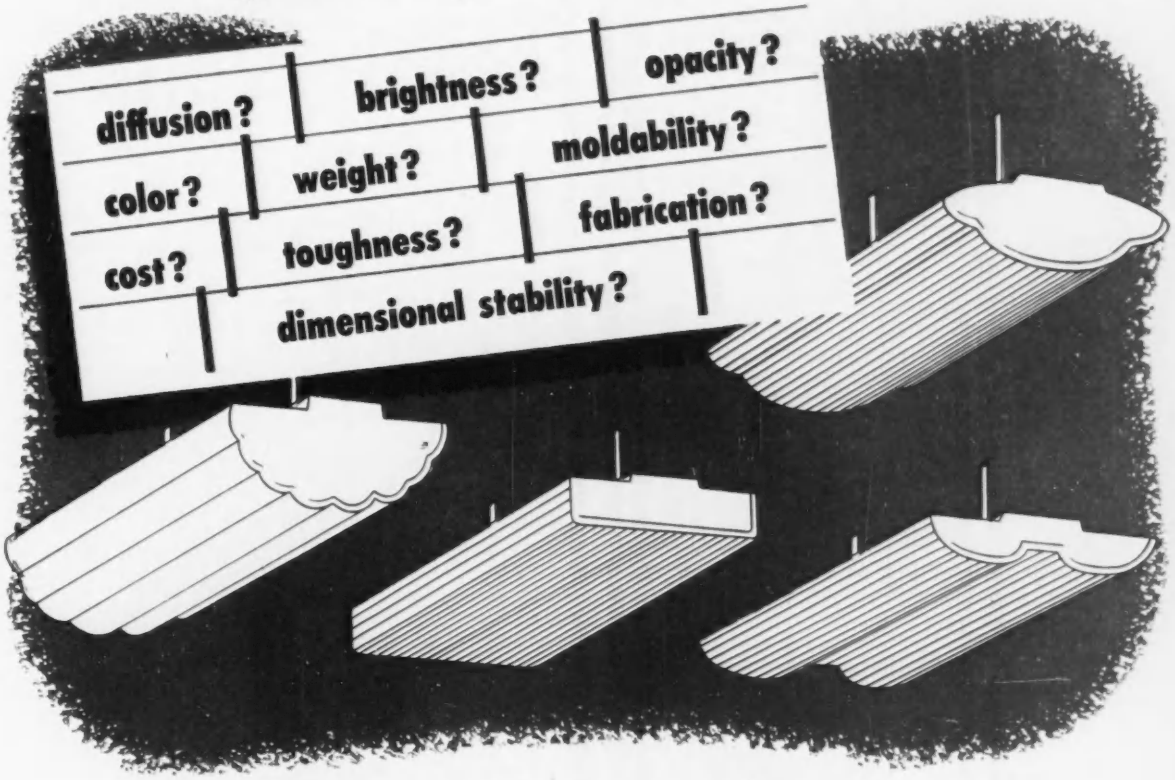
Single Section Precision Potentiometers

Available in single-section units with either a syncro-type or screw-type mounting, a new 1¾ in. dia precision potentiometer has been designed with both sleeve bearing and ball bearing models with torque requirements of 0.5 oz.-in. for the ball bearing unit. Standard linearity tolerance is ±0.3 percent. Mechanical rotation can be 360 deg continuous, or stops can be supplied for and rotation up to 330 deg. Electrical contact angles up to 360 deg. can be supplied, but the standard contact angle is 356 degrees.

Resistances from 2,000 to 200,000 ohms are available with a power dissipation of 3 watts at an ambient temperature of +25 C. Operating temperature range is from —54 to +71 C, and the unit will function



What's your lighting fixture problem?



Koppers "EVENGLO" Polystyrene is your best solution!

KOPPERS "EVENGLO" POLYSTYRENE can solve your lighting fixture problem best because it gives you more optical and mechanical advantages than other materials commonly used for fluorescent fixture applications.

"Evenglo" is optically superior because you can exercise more accurate control over opacity, diffusion and color in the finished product. In effect, you can specify the color tone of light, degree of brightness and amount of diffusion desired, and you can be sure your specification will be maintained exactly in each "Evenglo" panel, from first to last.

Koppers Polystyrenes 8X and 81 are the types normally used in formulating "Evenglo." Its high heat distortion temperature gives it a decided advantage over competitive polystyrenes. "Evenglo's" unrivaled combination of easy moldability, dimensional stability, light weight, ease of fabrication and low cost makes it a desirable choice over other plastics and glass.

Koppers application engineers will be glad to demonstrate the versatility of "Evenglo" Polystyrene and to recommend the "Evenglo" formulation that fits your specific requirements.

Write for New, Free Bulletin C-2-162

It contains technical data about "Evenglo's" physical and optical properties, and outlines the scope of its usefulness in the lighting field.

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We don't know the size of this man's dilemma . . . nor even the shape. But the man we're looking for is in a plastics dilemma. And that's why we'd like to find him . . . we think we can help him out of it. That's our job. So, if you know this man — and it could be you — why not ask him to contact us? Better make it *today!*

In plastics . . . from design to delivery . . . look to Watertown

WATERTOWN MFG. CO.

500 ECHO LAKE ROAD, WATERTOWN, CONN.

during 50G acceleration applied along any axis.

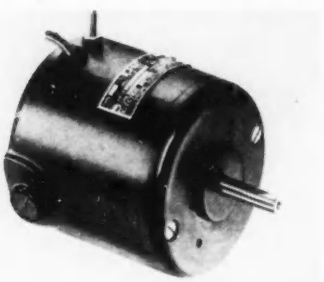
With their toroid coils, these units are used in applications requiring non-linear functional outputs without external taps. Weight is 2½ oz for the sleeve bearing unit and 3½ oz for the ball bearing units.

G. M. Giannini & Co., Inc.,
117 E. Colorado St., Pasadena 1, Calif.

Fan Motor For All Voltages

Specifically designed for use as a blower or fan motor for refrigeration space cooler or space heater applications, the EMC 710 motor is series wound, can be furnished for either a-c or d-c, and has a voltage range of 6V, 12V, 24V, 32V to 115 volts.

The motor is rated from 1/30 to 1/15 hp with a case of the totally



enclosed type that will stand water submersion and a wide range of temperature changes. Mounting is either band or flange type. The motor is available with permanently grease sealed sleeve bearings or precision ball bearings.

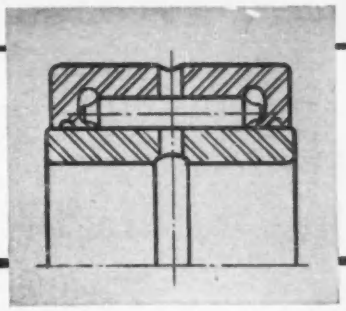
Howard Industries, Inc., Racine, Wis.

Motor Operated Field Rheostat

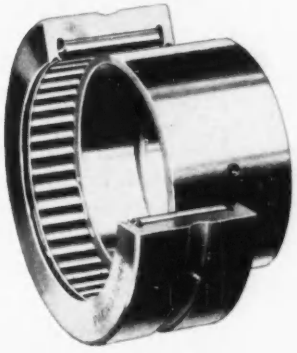
Using snap-action limit switches, this new type RK motor-operated field rheostat is designed to adjust the speed of d-c motors up to 200 hp and the voltage generators up to 300 kw. Two cam-operated switches are supplied with each unit, with each cam being adjustable over a 360 deg range from the front of the rheostat, and is available for 15, 45, and 90 deg travel. Additional switches are available for auxiliary circuits.

Two different gear ratios can be supplied: one permits full rheostat travel in from 5 to 15 seconds; the other has full travel in 15 to 45 seconds. The travel time can be adjusted

A bearing design of simplified construction reduces internal wear



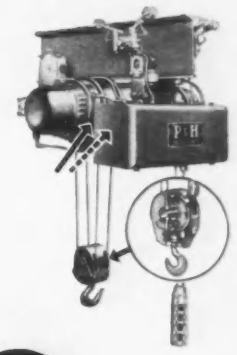
The performance efficiency and life expectancy of anti-friction bearings depends to a great extent on the ability of the bearing designers to hold internal wear to a minimum. They have found that wear can be materially lessened by reducing the number of bearing parts subjected to wear. In the case of MULTIROL SE Series roller bearings all parts have been eliminated except the anti-friction essentials of load carrying rollers and contacting races. Loose or welded in retaining rings and cages ordinarily found in roller bearings of this type have been discarded in the exclusive MULTIROL design.

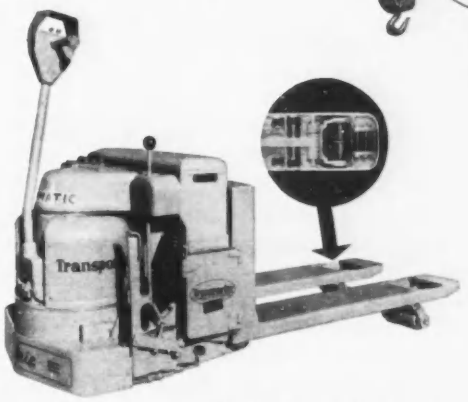


Here rollers are retained by rolled over lips on end shoulders that are solid extended sections of the outer race. Cages are not required and other delicate parts that may wear, warp or break loose in mounting or in service are not needed. Numerous other advantages accrue from this MULTIROL bearing construction in addition to reduced internal wear and longer bearing life.

Typical Performance

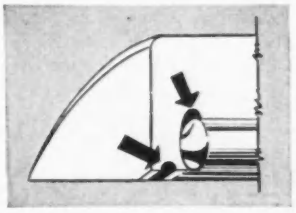
Harnishfeger P&H Hevi-Lift electric hoists carry up to 15,000 pound loads on MULTIROL SE series bearings. Their extra capacity and precision with ruggedness help reduce necessary radial bearing space in the upper and twin bottom sheaves. Two additional SE bearings add smooth efficient and dependable performance in the hoist transmissions.





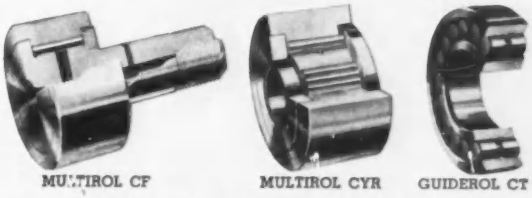
The Automatic Transportation Company's Transporter uses eight Multirol SE Series bearings in the four rear wheels to carry 6000 pound capacity loads easily and freely. Wheels are mounted dual on each fork and two bearings with a center spacer support each wheel. These small but rugged bearings accommodate a large shaft with a comparatively small O. D. and materially reduce starting and rolling friction for finger-tip maneuverability of this heavy duty material handler.

Lubrication Advantages



Important among these is the extra protection against destructive foreign particles provided in SE series bearings by a lubricant retaining groove, built into the inside diameter surface of the roller retaining end shoulder. The ring of lubricant held in this groove acts against the inner ring O. D., increasing the sealing effect of the precision tolerances between these shoulders and the inner race. Notice, too, the groove above the roller ends. Acting as a lubricant reservoir, this groove provides MULTIROL SE series bearings with an extra margin of protection against neglected or delayed lubrication.

Other McGILL® Bearings



MULTIROL CF MULTIROL CYR GUIDEROL CT

A new 140-page Bearing Reference Guide complete with 30 pages of vital engineering data has just been released by the McGill Manufacturing Company. It has the full story on the advantages of Multirol SE Bearings as well as information on the Multirol CF and CYR and Guiderol Bearings. Send now for your copy of McGill Catalog No. 52.

McGILL® — Precision Bearings

McGILL MANUFACTURING COMPANY, INC.
201 N. Lafayette Street, Valparaiso, Indiana

in INSTANT ICE MACHINES that spout up to 2 tons of flaked ice per 24-hour day

WINSMITH speed reducers

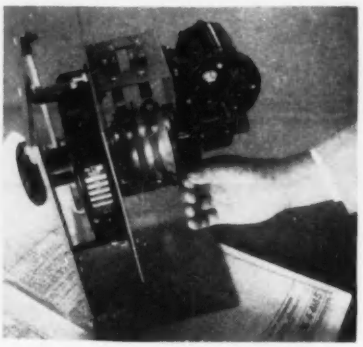
Jetting a steady stream of dry-cold, hard ice flakes at the touch of a button is the kind of magic this Instant Ice Machine was made for. That's its job. Hospitals, restaurants, hotels, dairies, meat packers and super markets count on it. And well they may — for Liquid Freeze Corporation, manufacturer of Instant Ice Machines, has been extremely careful in the selection of sturdy, long-lived components for tough day-in, day-out performance.

Centered in the drive mechanism powering the stainless steel blades which flake the ice, is a Winsmith Speed Reducer, Worm Gear Model 3 1/2 B, with an input speed of 2150 rpm and an output speed of 59½ rpm. "Chosen for adaptability, sound engineering design and construction . . . we have found it rugged and dependable in every way," says Liquid Freeze Corporation.

Reasons such as these have led manufacturers to look to Winsmith when they are looking for speed reducers. With fully standardized differential, worm gear, helical gear and worm-helical units — the Winsmith line is the most complete within its range of 1/100 to 85 hp and 1.1:1 to 50,000:1 reduction ratios.

Request catalog 148 for details.

WINSMITH, INC.
111 EATON ST.
Springville (Erie County), N. Y.



over a 3-to-1 range by inserting resistance in the motor circuit.

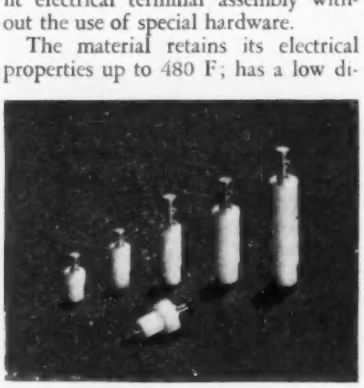
The drive mechanism of these rheostats mounts on the front panel, and up to three standard rheostat plates can be mounted on the rear of the panel, with all components accessible for inspection or adjustment.

Westinghouse Electric Corp., Box 2099, Pittsburg, Penn.

Press-Fit Terminals For Miniaturized Systems

Stand-off and feed-through terminals of Teflon make possible a press-fit electrical terminal assembly without the use of special hardware.

The material retains its electrical properties up to 480 F; has a low di-



electric constant; and a low loss factor that is constant over the full frequency range. Thermal stability makes it applicable for miniaturized systems having high operating temperatures.

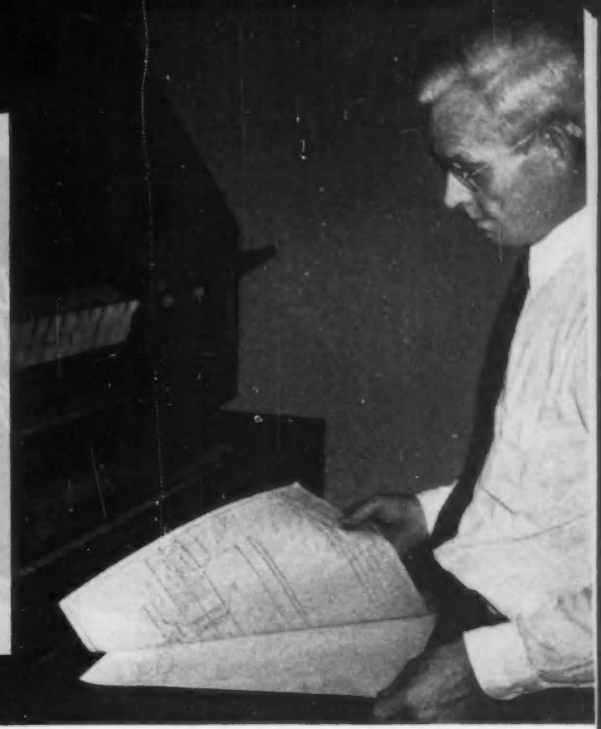
Sealectro Corp., 186 Union Ave., New Rochelle, N. Y.

Multi-Speed, Explosion Proof Motor

For use in aircraft, and designed to operate in hazardous locations on 400 cycle, 3-phase a-c, this multi-speed, explosion-proof motor with brake develops ⅓ hp at 5200 rpm. With a d-c actuated brake, multi-speed

Important savings at Eureka-Williams Corp. because

ALL drawings are reproduced on Kodagraph Autopositive Paper



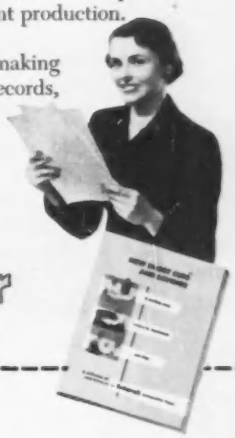
Positive photographic intermediates are produced *directly*, without the negative step. A standard print-making machine is used for exposure; standard photographic solutions for processing. A fast, easy room-light operation *that saves time and money!*

In print production . . . no wear-and-tear to valuable originals. The Eureka-Williams Corp., Bloomington, Ill., protects its ever-growing investment in drafting time and dollars by using low-cost Kodagraph Autopositive intermediates to obtain the desired number of shop prints. These intermediates, unlike the original drawings, will not smudge or lose line density with repeated printings . . . will produce highly legible prints time after time. Furthermore, their dense photographic black lines and evenly translucent base permit running the prints at uniform, practical speeds. *Which adds to the convenience—and the economy.*

In drafting . . . revisions made 7 times faster. The basic designs for Eureka-Williams oil burners, furnaces, and vacuum cleaners are being modified constantly for the production of various models. Here's just one way Autopositive is used to boil 3 days of drafting time down to 3 hours—

1. An Autopositive intermediate is made of the drawing which is to be revised.
2. The draftsman deletes the unwanted parts of this print with a razor blade.
3. From this, another Autopositive intermediate is made.
4. Then the draftsman only has to add the new design . . . and a new "file original" is ready. From it, additional Autopositives can be made for print production.

Costs are also cut by making Autopositives of office records, and other non-translucent records which are unsuitable for use as print-making masters.



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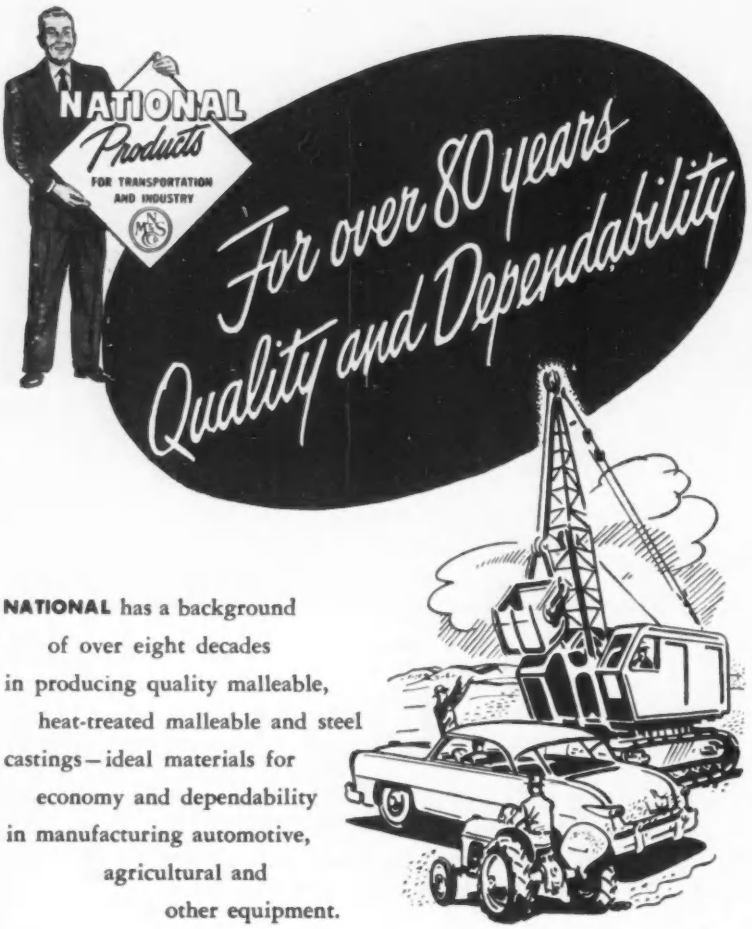

NATIONAL has a background of over eight decades in producing quality malleable, heat-treated malleable and steel castings—ideal materials for economy and dependability in manufacturing automotive, agricultural and other equipment.

NATIONAL's unparalleled experience—coupled with a continuing metallurgical research program, rigorous quality control standards, and completely mechanized foundries in strategically located cities—is at your disposal.

Sales offices and engineering facilities are located at all five plants listed below.

SEE "This Moving World"

A 16mm Technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings. A-5017

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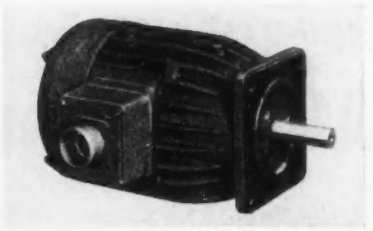
NATIONAL Products FOR TRANSPORTATION AND INDUSTRY Est. 1868

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY
CLEVELAND 6, OHIO



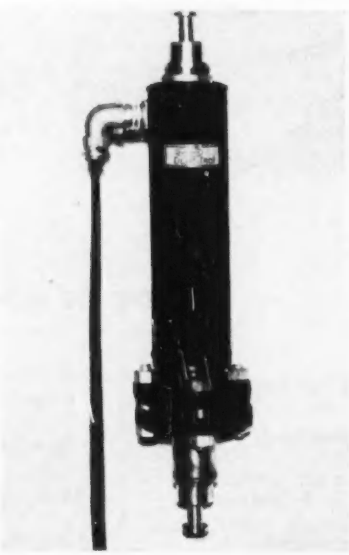
windings, and explosion-proof construction, this motor is double enclosed, with a fan blast being directed over the heat dissipating fins for maximum cooling.

Features include: pre-packed ball bearings; d-c actuated brake; explosion-proof, moisture resistant AN connector; thermal overload protection; two speed windings, AN mounting pad, high torque, and rapid acceleration.

U. S. Electrical Motors, Inc., Aircraft Div., 200 E. Slauson Ave., Los Angeles 54, Calif.

Indicates, Records and Controls Liquid Density

Continuously indicating, recording, and controlling the density of flowing liquids is possible with a new instrument known as the Densitrol, which is available in different models, the most basic of which offers direct sight readings of liquid density at the pipe-line point of sampling. Other models, give continuous indication or recording of liquid density at a distance from the sampling chamber itself. They can be installed to directly control density in such liquid processing operations as blending, mixing, proportioning, di-



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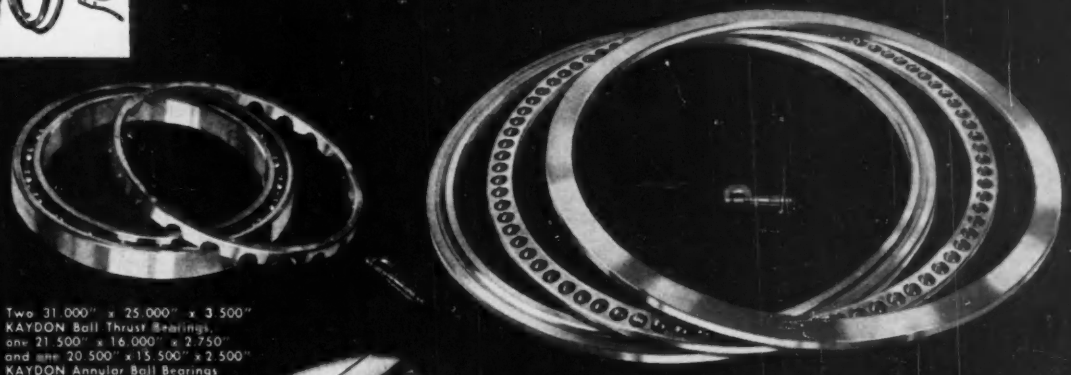
To be sure that your request will receive prompt and careful attention, please write or print legibly your name, company affiliation, and address. This service is valuable to you only if you use it. We welcome your comments and suggestions at any time.

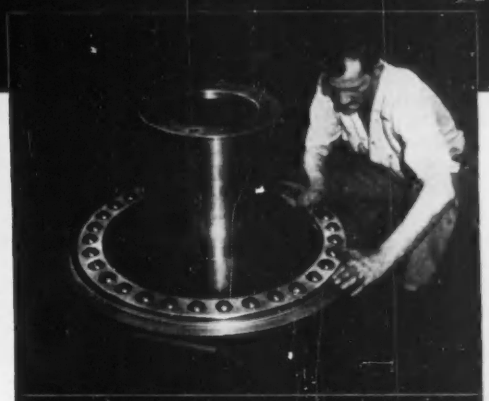
Contact KAYDON Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



Two 31.000" x 25.000" x 3.500" KAYDON Ball Thrust Bearings, one 21.500" x 16.000" x 2.750" and one 20.500" x 15.500" x 2.500" KAYDON Annular Ball Bearings are used on world's largest glass-press.

Where do KAYDON 31-inch bearings fit in T-V sets?



5-ton table of press rides smoothly on KAYDON bearings

Obviously there's no place for 31-inch bearings in 21-inch T-V sets . . . but four husky **KAYDON** super-precision bearings are vital factors in producing large T-V tube face-plates (21-inch and up), made on the world's largest glass-press, a product of Lynch Corporation, Anderson, Indiana.

KAYDON bearings were engineered into this huge Lynch "ELP" 120-ton toggle press to support its 5-ton table and to accurately guide the terrific pressure-strokes that form precision T-V face-plates from gobs of molten glass. Now mass production of face-plates is assured with unvarying precision and faultless interchangeability, for dependable T-V reception.

Similarly, **KAYDON** bearings help designers improve military equipment, aircraft, automotive and many modern heavy-duty industrial machines, to help manufacturers make precision products better, faster, more profitably. On machines you *make* to *sell*, or *buy* to *use*, specify **KAYDON** bearings. Capable **KAYDON** engineers are prepared to cooperate with your technicians. Contact **KAYDON**.

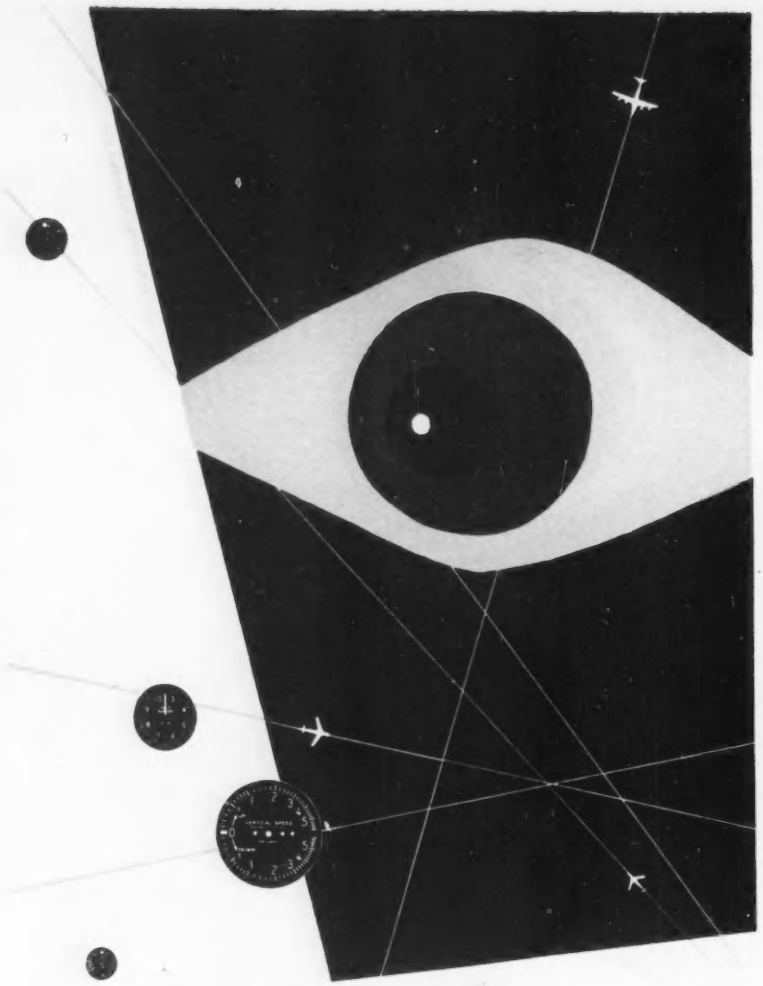
Huge 120-ton Lynch "ELP" Glass Press being assembled

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS



SEEING IS BELIEVING

Supplying the right answers to pilots and navigators by means of accurate, reliable instruments has been our work for more than twenty-four years.

- AIRCRAFT INSTRUMENTS AND CONTROLS
- OPTICAL PARTS AND DEVICES
- MINIATURE AC MOTORS
- RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT

Current production is largely destined for our defense forces; but our research facilities, our skills and talents, are available to scientists seeking solutions to instrumentation and control problems.

kollsman INSTRUMENT CORP.

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF Standard COIL PRODUCTS CO., INC.

luting or concentrating, with resultant savings in time, materials and equipment.

The density-sensitive element in the instrument is a totally-submerged plummet, fastened by a chain of known weight to a fixed reference point. For each density within the range of this plummet-chain assembly, the plummet assumes a definite equilibrium position. Any changes in plummet position are translated through the plummet core and an electrical position measuring device into continuous indication, record, or control of liquid density.

Any calibration can be furnished (Baume, Specific Gravity, A.P.I.) within the range limits of 0.2 to 0.005 density or equivalent full scale change within the limits 0.5 to 3.5 density or equivalent. Accuracy for all ranges is ± 3 percent of range or 0.0002 density, whichever is greater. Sensitivity for all ranges is $\pm \frac{1}{2}$ percent of range.

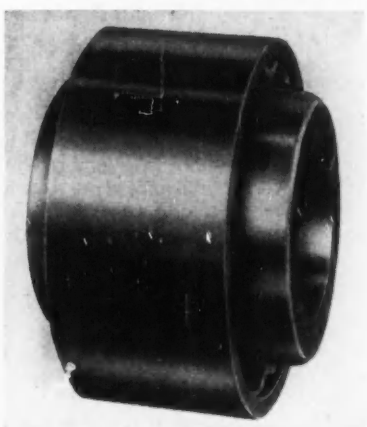
Automatic compensation for change of temperature in the sampled liquid is built-in, and the constructions are offered for operating temperatures up to 630F. Models are also available for operating pressures up to 600 psi.

Precision Thermometer & Instrument Co., 1434 *Brandywine St., Philadelphia* 30, *Pa.*

Easily Disassembled, Gear Type Flexible Couplings

Gear Type flexible couplings for worm shafts, gear shafts, and electric motor shafts consist of seven parts: a sleeve; two hubs; two neoprene seals; and two snap rings. The coupling is said to be easily disassembled, and is sealed to keep weather out and lubrication in.

The hubs and sleeve are SAE 1045 steel forgings with 90,000 psi tensile



strength. The couplings allow an average of 3 deg angular misalignment and $\frac{1}{16}$ in. offset depending on the size.

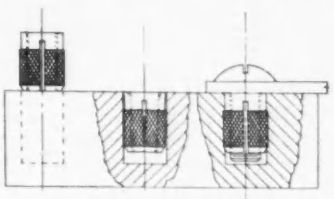
The standard couplings are made in 22 bore sizes from $\frac{3}{4}$ in. to $6\frac{1}{2}$ in. dia. with capacities from 4 to 550 hp. Other designs, including mill motor, spacer, vertical shaft and floating shaft types are available in a range of bore sizes from $\frac{3}{8}$ in. to $6\frac{5}{8}$ in. diameter.

Michigan Tool Co., Cone-Drive Gears Div., 7171 E. McNichols Rd., Detroit 12, Mich.

Screw Locking Inserts Replace Molded Inserts

Knurled inserts, whose three-stage principle of operation is shown in the illustration, have been designed to take the place of molded inserts. Besides locking the screw, they require no special tools for installation.

In the middle view above, the insert has been installed and the tapped hole has become tapered. The body



so engages the work that the insert will not turn when the screw is entered. The screw enters the tapered hole and expands the insert, sinking the fin into the work. This pressure locks the screw. The smaller the hole, the greater the locking action.

Standard knurled inserts are made of aluminum, but are available in other materials and a range of sizes for screws from 4-40 to $\frac{1}{4}$-20.

Brush Nail Expansion Bolt Co., Greenwich, Conn.

Precision Potentiometers And Rheostats

A new series of panel mounting precision potentiometers, Dekapot model DP-211, have linearity to better than ± 0.01 percent and total resistance to better than ± 0.05 percent.

Instead of the singled resistance element, the dekapot has two decades of fixed resistors and an interpolating slidewire to accomplish the voltage division. The dial arrangement gives an effective scale length of 390 in., which is approximately the equivalent of a 100 turn helical potentiometer.

By using non-reactive precision fixed

THERE IS AN R-B-M CONTROL To Fit Your Needs

A.C. MAGNETIC STARTERS with Plasti-Clad Magnet Coil
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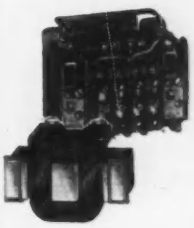
Write for Bulletin 605



Full accessibility in a small package.

Contacts, coil and thermal element replacement with use of screwdriver only. Magnet coil—in molded phenolic case with riveted terminals—is completely embedded in a rock-hard resinous material, thus protecting against oil, dirt, moisture and normal mechanical damage.

HERMETICALLY SEALED RELAYS
•
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50% smaller — lighter.

R-B-M 22204-0 meets AN 3304-1 specifications. R-B-M engineers have developed the 22300-0 currently used in government electronic, airborne and ground equipment—as the electrical and mechanical equivalent of the AN 3304-1, yet 50% smaller in size with ½ the weight.

INDUSTRIAL CONTACTORS with Plasti-Clad Magnet Coil
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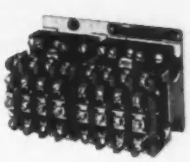

2-8 poles Non-Reversing.
2-5 poles Reversing.
25 Amp — 600 AC Max.

Contacts can be replaced without removing wiring. To change coil, remove magnet frame and coil assembly only. 10 and 15 amp. poles can be changed from normally open to normally closed by using screwdriver only.

GENERAL PURPOSE RELAYS
•
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•

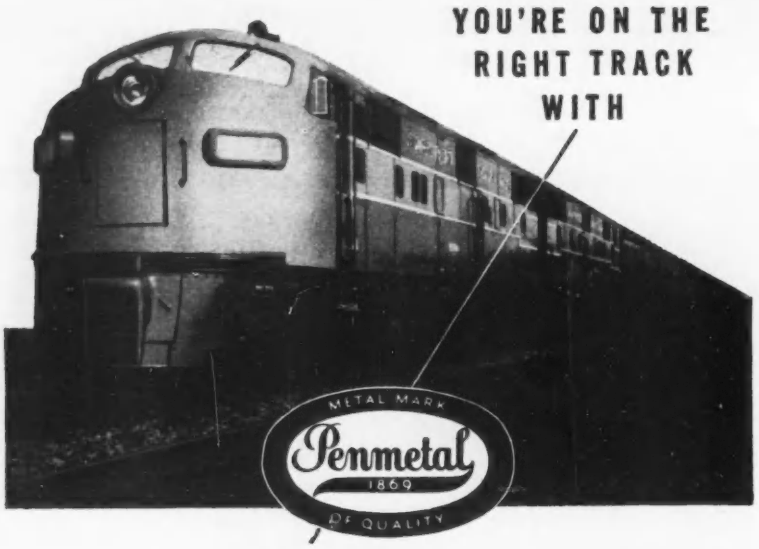
Low cost. Small size. Dependable performance. Available in many contact arrangements.

Whatever your needs for inexpensive, dependable relays for commercial applications—investigate R-B-M General Purpose Relays.

Other R-B-M products include: motor overload protectors, motor starting relays and low voltage DC electrical devices.

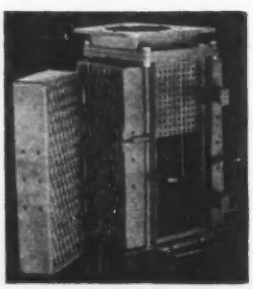
Consult R-B-M On Your Control Problems—Write Department C-6

RBM
R-B-M DIVISION ESSEX WIRE CORP.
Logansport, Indiana
MANUAL AND MAGNETIC ELECTRIC CONTROLS — FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE



EXPANDED METAL MESH

Cheapest "Diamonds" You Can Buy



Farr Filter Adapter Assembly used extensively on freight and passenger locomotives.

1000's OF USES

Railroad Air Filters, for example: Penmetal Expanded Metal Mesh is strong, good-looking, light-weight, non-warping, fireproof. It is easily formed, shaped and welded . . . weighs as little as 10% of the solid sheet. That's why the Farr Company of Los Angeles uses Penmetal Expanded Metal Mesh in the design and construction of Far-Air Filters for Diesel Locomotives, Passenger Cars, Air Compressors and special railroad applications.

MAKES A LITTLE METAL GO A LONG WAY. Penmetal Expanded Metal Mesh is sheet metal—slit, then stretched up to 10X its original area. Resulting diamond truss pattern adds rigidity—permits free passage of heat, light, sight, sound and air. Available in corrosion-resistant metals and carbon steel. Large or small mesh, light or heavy gauge.

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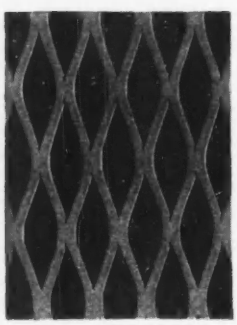

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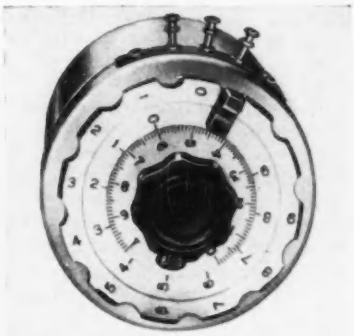
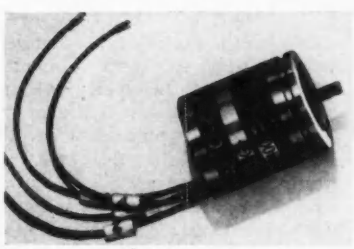


resistors in the resistance decade, good frequency response is possible. The resistance wire used has a temperature coefficient of less than ±0.002 percent deg centigrade. These units are available in total resistances of 10,000 ohms.

Brown Electro-Measurement Co., 4635 S.E. Hawthorne Blvd., Portland 15, Ore.

Miniature Servo Motors In Variety of Frequencies

Miniature precision servo motors, smaller than a postage stamp, are about one inch in dia., slightly over one inch in length, and are available for frequencies varying from 60 to 400



cycles, and in 2, 4, or 8 pole construction. Stall torque ranges from 0.25 to 0.35 oz.-inch. The output shaft can be supplied to suit, with or without intergral pinion.

G-M Laboratories, Inc., 4300 Knox Ave., Chicago 41, Ill.

New Type Precision Potentiometer

A new type of potentiometer (voltage dividing resistor) of larger size and greater precision is the latest addition to the line of ultra-low-torque instruments. Offered with a shaft torque as low as 0.025 oz.-in., it is applicable to devices where a small mechanical force must be converted into an equivalent electrical voltage.

This model, type 1418, was de-

veloped for use in computers and fire control equipment where mechanical and electrical precision are essential for satisfactory operation. The servo type mounting and ball bearing shaft, ABEC class 5, feature easy installation and adjustment, and are said to have minimum physical and electrical stability under extremes of shock, temperature and vibration.

Potentiometers are available with resistance values between 100 and 350,000 ohms, rated at 3 watts, electrical rotation up to 360 deg., many taps and brushes, linearity to 0.1 percent and resolution down to 0.03 percent. The toroidally wound resistor element is $3\frac{3}{4}$ in. long.

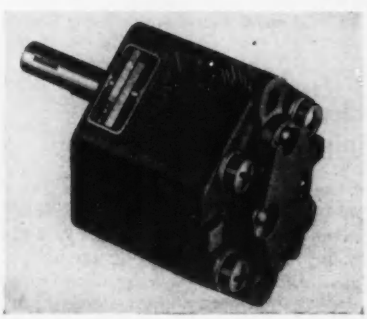
The instrument is 1.437 in. dia by 1.03 in. long, exclusive of the 0.125 in. shaft, and weighs 0.102 pounds. Color coded wire leads or screw type terminals are also available instead of solder terminals.

Electro-Mec Lab.,
19 Murray St., New York 7, N. Y.

Gear Type Pumps Have Many Applications

To a line of gear type, hydraulic pumps has been added the LB series, a new pump designed for a variety of uses such as: pressure lubricating; oil circulating; transfer and filtering systems; lift; and replenishing systems.

The LB pump is available with three capacities: 2.5, 3.5, and 4.5 gpm at 1800 rpm and 100 psi. Pressures or speeds in excess of these may be used in selected applications. The design



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paint base
bright finishes
final finishes
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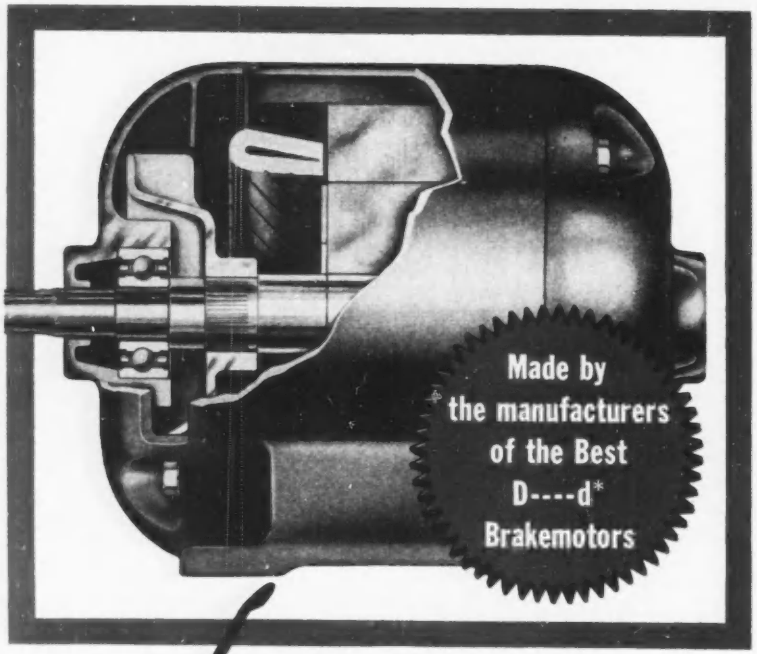

You get *Longer* service life when you specify STAR-KIMBLE squirrel-cage motors

because

Extra insulation
—three separate wrappers on every coil—provides added safety factor for possible rises above rated temperature.

Prelubricated bearings
—double-width cartridge type—run for years without any attention.

Ventilating fan
keeps motor windings cool.

Dynamic balancing
of skewed rotor minimizes vibration.

Smooth lines
eliminate dust-catching crevices.

*Demanded by industry for tough start-and-stop jobs.

OTHER FEATURES:

Rotor and stator surfaces ground for uniform air gap. Rugged construction—twice as many ribs as used in conventional designs, in frame sizes through NEMA 364. Standard NEMA designs "B", "C" and "D" . . . NEMA C Face and D Flange mountings . . . PLUS a wide range of special electrical and mechanical designs to meet specific needs.

For further information, write for Bulletin B-201

STAR-KIMBLE
MOTOR DIVISION
MIEHLE PRINTING PRESS AND MFG. CO.
211 Bloomfield Avenue Bloomfield, New Jersey

of the LB pump permits use in pumping most liquids having a substantial oil base.

The LB Series consists generally of two types of pumps: type LBP (shown) and type LBS. Model LBP is designed for face mounting or wet sump application; model LBS includes a shaft seal and is recommended for direct, gear or belt drives. The LBS is available also as a 115/230 volt motorpump combination.

An internal relief valve, adjustable for pressures between 50 and 200 psi, is optional. It cannot be used for a control or for pressure regulating.

Webster Electric Co.,
1900 *Clark St., Racine, Wis.*

Miniature Switching Key

A new miniature anti-capacity switching key which weighs 2⅛ ounces and combines compactness with increased reliability and long life is designed to provide more contact in less space.

The unit consists of four sets of transfer contacts on each side. The key

is non-locking in both directions. It is mounted on an aluminum frame with four screws and can be removed from the key frame for inspection and adjustment. Other features include a molded spring nest and a special restoring spring heat-treated for maximum life and endurance.

Federal Telephone & Radio Corp.,
Clifton, N. J.

Electrically Actuated Impulse Counters

Compact, electrically-actuated impulse counters designed for flush panel mounting are about 4 in. long, and mount through a panel opening about ¾ in. high and 1¼ in. wide. The front panel of the unit contains a 4-position

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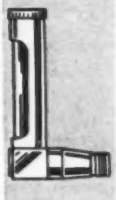
Yes, for 40 years GITS has been setting the standard for industry . . . solving tough lubricating problems . . . earning the confidence of manufacturers . . . it's the reason people say, "Call GITS first".



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Yes, GITS oil cups can do a complete lubricating job for you . . . prolonging bearing life, reducing maintenance costs, cutting down-time, boosting production . . . and GITS oil cups cost so little.

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Yes, GITS is known for uniform quality in design, materials and machining . . . this means constant, dependable performance for you. Inferior products can cost you time and money. Demand the best . . . get GITS.

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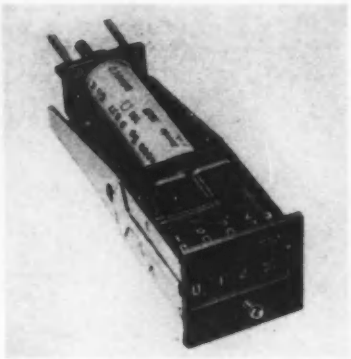
1406 Union Street, Glenbrook, Conn.



counting index with $\frac{5}{32}$ in. high, white numerals, and an instantaneous zero-reset button.

Any of seven different coils are available for impulse voltages between 4 to 60 volts d-c, or rectified a-c. Power requirements range between 1.4 and 2.5 watts, depending on the voltage used.

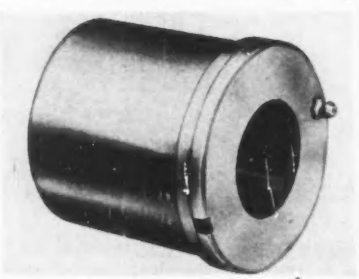
Maximum counting rate: 10 impulses per sec; minimum impulse duration: 40 milliseconds; minimum break between impulses: 50 milliseconds. The units digit advances half a unit when the coil is energized, and completes its advance when the coil is de-energized.

Landis & Gyr, 45 West 45 St., New York 36, N. Y.

Sealed Needle Bearing Pilot Bushing

Featuring absolute sealing of the bearing cavity, a new precision needle bushing seals against dirt, coolants, and grit, and increases the effectiveness by permitting closer center distances than roller type bushings.

The bushings can be disassembled without removing the housing, they



protect against thrust loads as well as radial, and are adaptable to keys or keyways.

Range of bore sizes is from 0.257 in. to 2.00 inches; total overall length is from $1\frac{1}{4}$ to $3\frac{1}{2}$ inches.

J. G. Jergens Co., 11106 Avon Ave., Cleveland 5, Ohio

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June 1-12

CANADIAN INTERNATIONAL TRADE FAIR—Exhibition Park, Toronto, Canada.

June 7-12

SOCIETY OF AUTOMOTIVE ENGINEERS—Summer Meeting, Ambassador Hotel and Ritz-Carlton Hotel, Atlantic City, N. J.

June 15-18

AMERICAN ELECTROPLATERS' SOCIETY—Annual Convention, Benjamin Franklin Hotel, Philadelphia, Pa.

June 15-19

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Summer General Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 15-19

EXPOSITION OF BASIC MATERIALS FOR INDUSTRY—Grand Central Palace, New York, N. Y.

June 16-19

AMERICAN WELDING SOCIETY—Spring Technical Meeting and Allied Exposition. Shamrock Hotel, Houston, Texas.

June 29-July 3

AMERICAN SOCIETY FOR TESTING MATERIALS—Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

August 17-19

SOCIETY OF AUTOMOTIVE ENGINEERS — International West Coast Meeting, Georgia Hotel, Vancouver, B. C., Canada.

August 19-21

WESTERN ELECTRONIC SHOW AND CONVENTION — Municipal Auditorium, San Francisco, Calif.

September 1-4

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Pacific General Meeting, Hotel Vancouver, Vancouver, B. C., Canada.

September 14-17

SOCIETY OF AUTOMOTIVE ENGINEERS—National Tractor Meeting and Production Forum, Hotel Schroeder, Milwaukee, Wis.

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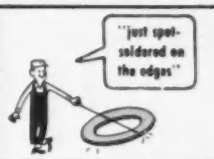

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The laminations of the LAMISOL Shim (in brass only) are temporarily joined by spot-soldering on the edges. Gauges and number of laminations within one shim are unlimited.

THE LAMITAB* SHIM

FOR SUPER SPEED, THIN GAUGE SITUATIONS
The little tab holds shim laminations together firmly, yet is easily removed. Different metals can be used in the same shim.

THE LOOSE LEAF SHIM

FOR UNLIMITED FLEXIBILITY
This is the simplest of all custom-stamped shims. It is completely flexible. Usually sets including several different gauges are made up.

PACKAGED SHIM STOCK

READY FOR EASY USE, WITHOUT WASTE
Thin gauge 6" x 100" rolls feed through package slots. Heavier gauges in flat envelopes. Available from your Industrial Distributor.

*T.M. Applied For

LAMINATED SHIM COMPANY, INC.

SHIM HEADQUARTERS SINCE 1913

Check Our Stampings Division For Your Stamped Parts Requirements

USE COUPON for more information

MAIL TODAY!

LAMINATED SHIM COMPANY, INC.
1406 UNION STREET, GLENBROOK, CONN.

Please send me more information on:

☐ SHIMS ☐ STAMPINGS ☐ BOTH

☐ *We'd like to discuss our problem with one of your Sales Engineers.*

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COMPANY _____

STREET _____

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10,000 WATTS A.C.

with half the weight! in half the space!

MODEL 10CW
10,000 watts A.C.

the New ONAN "10 CW" Electric Plant

Check these advantages!

- ★ High capacity for big jobs.
- ★ Twin-cylinder, horizontally-opposed, air-cooled, alternate-firing engine.
- ★ Aluminum-alloy cylinder heads.
- ★ Extra-large, replaceable bearings.
- ★ Full-pressure lubrication, 6-quart oil capacity, oil filter.
- ★ Impulse-coupled, high-tension magneto ignition; radio suppressed.
- ★ Quiet, vacuum air cooling of generator and engine.
- ★ Excellent accessibility; snap-off housings.
- ★ Extremely quiet running.
- ★ High performance generators.
- ★ Completely equipped with controls and instruments.

Costs less than any other complete electric plant!

You can't match it anywhere in performance, equipment or value! Wherever you need an independent source of electricity . . . for trailers, cranes, loaders, any kind of mobile equipment, the Onan CW has many exclusive advantages. It is compact, lightweight, and amazingly quiet-running. Its exclusive Uni-Duct vacuum cooling system simplifies installation. All moving and heated parts are safely enclosed. Air-cooling avoids trouble from leaking or freezing of coolants. Unit-built, *direct*-connected construction and massive bearings assure long-life and minimum maintenance.

Model 5CW
5,000 watts
Same advanced design as the 10CW with all its exclusive advantages. Built for heavy duty, economical operation.

Write for Detailed Specifications!

D. W. ONAN & SONS INC.
Onan ELECTRIC PLANTS
6868 University S.E., Minneapolis 14, Minnesota

Catalogs and Bulletins

Request additional information using postcards following page 278

(1) MICRO-FOG LUBRICATORS—C. A. Norgren Co., Bulletin 485-7500, 2 pp. Has function, applications, features, and complete performance characteristics of a micro-fog lubricator used for spindles, bearings, gear boxes and small air operated devices. Oil particles 2 microns in diameter. Has cross-sectional view of lubricator showing how fog is created.

(2) SOLENOIDS—Trombetta Solenoid Corp., Bulletin, 32 pp. Data on a line of explosion-proof solenoids; oil-immersed solenoids; solenoid operated shoe brakes; solenoid operated disk brakes; recipromotors; and semotors. Push and pull types for all voltages and frequencies, a-c or d-c; push and pull characteristics are the same for all frequencies from 25 to 65 cycles. Has complete characteristics, engineering drawings, and curves.

(3) FLOATING MOTOR DRIVES—Reliance Electric & Engineering Co., Bulletin F-2051, 4 pp. Used in a roller table construction, where the floating motors ride on the shaft of the roll, preventing a displacement of the drive unit with reference to the roll. Has data and illustrations on floating motor drives with speeds from 200 to 750 rpm, and floating worm gear-motor for roll speeds from 25 to 300 rpm.

(4) V-BELT PUMP UNITS—Tuthill Pump Co., Catalog 107, 8 pp. Complete specifications and operational data for a pump unit for handling heavy fuel oils and other non-corrosive viscous liquids in circulating and transfer service. Used with motors up to 5 hp, giving pressures up to 300 psi.

(5) TRANSFORMER LAMINATIONS—Allegheny Ludlum Steel Co.,

Catalog EM3, 124 pp. Technical information and full-size drawings of all available standard shapes obtainable in a number of magnetic materials and a variety of thicknesses. Each lamination provided with a weight table.

(6) GOVERNMENT SPECIFICATIONS—E. F. Houghton & Co., Bulletin 2-27-E, 16 pp. Products meeting various specifications are listed under the following classifications: rust preventatives; lubricants; cutting oils; metal working aids, and leather and synthetic rubber products.

(7) ELECTRONIC ADJUSTABLE-SPEED DRIVE—General Electric Co., Booklets GEA-5827 and 5829, 8 pp. Describes two models of the Thy-motral drive for $\frac{3}{4}$ to 3 hp, and for $\frac{3}{4}$ to 10 hp applications such as: testing equipment; printing presses; variable volume or proportioning pumps; machine tools, processing equipment; conveyors; and others. Has operating characteristics, and specifications.

(8) FRICTION CLUTCH—Link-Belt Co., Booklet 2437, 4 pp. Has schematic drawings and dimensional tables to aid in the selection of the right friction clutch couplings. Features positive action and easy adjustment. In 10 sizes from $2\frac{3}{4}$ to 125 hp at 100 rpm.

(9) TRANSFORMER GUIDE—General Electric Co. Catalog GEA-4626 F, 102 pp. Contains ratings, and ASA accuracy classifications of indoor and outdoor potential and current transformers. Lists ratio and phase-angle test, plus tables covering the mechanical and thermal limits of current transformers. Has photo of each type.

(10) RELAYS—Sterling Engineering Co., Inc., Catalog 53, 24 pp. Has illustration, description, operational data, and specifications for: long and short coil telephone types; 3 miniature types; a two coil variation of the long telephone type; a-c multi-contact types; and sealed and plug-in units. List standard wiring diagrams and coil types.

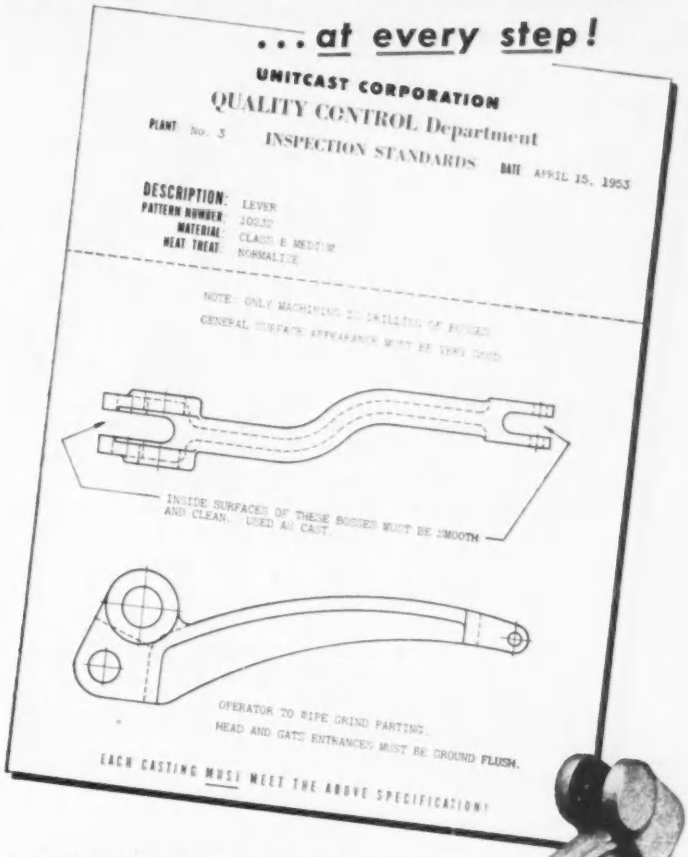
(11) GLOBE, ANGLE, CHECK, & FEED-LINE VALVES—Edward

NO. 1 IN A SERIES

UNITCASTINGS are consistently better!

MORE RIGID INSPECTION

...at every step!


UNITCAST CORPORATION
QUALITY CONTROL Department
PLANT No. 3
INSPECTION STANDARDS
DATE APRIL 15, 1953
DESCRIPTION: LEVER
PATTERN NUMBER: 10532
MATERIAL: CLASS B MEDIUM
HEAT TREAT: NORMALIZE
NOTE: ONLY MACHINED SURFACES OF CASTING OF BOSSES
GENERAL SURFACE APPEARANCE MUST BE VERY GOOD
INSIDE SURFACES OF THESE BOSSES MUST BE SMOOTH AND CLEAN. USED AS CAST.
OPERATOR TO RIPE GRIND PARTING.
HEAD AND GATE ENTRANCES MUST BE GROUND FLUSH.
EACH CASTING MUST MEET THE ABOVE SPECIFICATION!

A special *Inspection Standards* sheet follows every job through our foundry to guarantee that each casting and finishing operation meets your requirements *as specified!*

This rigid, *step-by-step* inspection control assures you that *every* UNITCASTING will be to *your* specifications . . . from raw material to finished appearance. Another *quality control* service you can rely on with Unitcast.

UNITCAST Corporation
QUALITY STEEL CASTINGS

Our steel casting specialists welcome the opportunity of working with you on your parts problems... their suggestions at the design stage can pay you continuous dividends.

Write or call . . . Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio; 701 New Center Bldg., Detroit, Michigan; In Canada: Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS are FOUNDRY ENGINEERED

Before you tie up funds in costly tools and dies, have Milford fastener-engineers analyze your product assembly need . . . at the design stage, while plans are still flexible. It will save you money and headaches, reduce production expense, speed up assembly time, and aid you in making a better product . . . perhaps at a competitive price advantage! You can put these savings in your pocket by sending drawings and detailed description of your product fastening problem for Milford's scientific solution.

Write for your copy of the "Milford Method for solving industry's fastening problems".

EST. 1919

MILFORD

the name to rivet in your memory for fasteners

THE MILFORD RIVET & MACHINE CO.

877 Bridgeport Avenue, Milford, Conn.
830 Illinois Ave., Aurora, Ill.
1124 W. River St., Elyria, Ohio
44 Platt Street, Hatboro, Penna.
727 So. Palm Ave., Alhambra, Calif.

Valves, Inc., Catalog 12-c, 50 pp. Complete information on globe, angle, and check valves for hand or motor control of volumes are described. Also has information on material specifications, preparation of welding ends, pressure-temperature ratings and other engineering data.

(12) MOLDED NYLON PLASTICS—General Electric Co., Bulletin CDP-654, 4 pp. Suggests mechanical applications and design possibilities. Describes strength, light weight, self-lubrication and other advantages. Tables give mechanical. Thermal, electrical, and other properties.

(13) MOLUB-ALLOY LUBRICANT—Imperial Oil & Grease Co., Inc., Bulletin, 8 pp. Describes a new lubricant made in a range of types and weights from high quality hydrocarbon base stock, or synthetic or volatile base material having micron-sized particles of metallic-solids added. One of the solids used is molybdenum disulphide.

(14) AIRCRAFT ENGINE STARTERS—Jack & Heintz, Inc., Bulletin 1500, 10 pp. Descriptive data, performance curves, cutaway drawings and photos of a line of starters, including those for both reciprocating and turbojet engines, and aircraft-type tank engine starters.

(15) NEEDLE VALVES—Fluid Controls, Inc., Data Sheets 3.61 & 3.62, 2 pp. Has engineering, design and construction features, including specific data on pipe size, dimensions, weights and performance characteristics of a line of $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ in. needle valves for oil up to 3,000 psi.

(16) RECORDER CONTROLLER—The Foxboro Co., Bulletin 465, 16 pp. Describes the circular case controller, used to automatically control temperature, pressure, liquid level, humidity or other process variables. Discusses each unit of a pneumatic control system from the measuring element to the control valve. Explains how to select the controller action to match the demands of a process.

(17) CLOSE-COUPLED CENTRIFUGAL PUMPS—Carver Pump Co., Bulletin 211. Information on the model B close-coupled motor driven

centrifugal pump made in two sizes: 1 in. and 1¼ in. discharge, and will pump up to 70 gpm and heads up to 110 ft.

(18) BALL SCREW ASSEMBLIES Vard, Inc., Bulletin, 12 pp. Illustrations of a line of ball screws, ball screw actuators, electro-mechanical actuators, gears, gear boxes, and other aircraft components. Compares ball screw assembly with acme screw. Has specifications of ball screw units with ball dia. from 0.063 to 0.406 inch.

(19) INSTRUMENT TUBING—Samuel Moore & Co., Bulletin L-6506, 4 pp. Describes several kinds of corrosion-proof plastic-coated tubing: DeKoron instrument tubing, a single-line metal tubing with plastic sheath; Metl-Cor, multiple metal harness with polyethylene coating; Poly-Cor, multiple polethylene tube harness with vinyl sheath. Metl-Cor is available with 4, 7, or 10 tubes; Poly-Cor with 4, 7, 10, 14, or 19 tubes.

(20) BALL BEARINGS—Nice Ball Bearing Co., Catalog 150. Listings cover: standard radial; thrust, and combined radial-thrust bearings of both precision and unground types, and include several new lines. Special bearings, ball bearing rollers, sheaves and wheels are included. Also gives capacity ratings, complete specifications and engineering data.

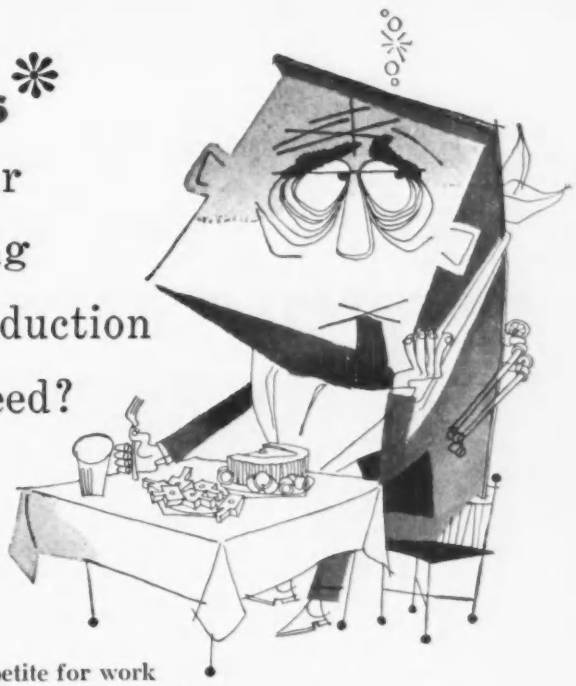
(21) TEMPERATURE REGULATORS—Farris Stacon Corp., Bulletin ST162, 8 pp. Illustrations, cross-sectional views and complete specifications and data on a line of self-operating temperature regulators. Also information on how to select regulators for: steam; gases; liquids; and vapors.

(22) DIESEL ENGINE PRIMER—Harnischfeger Corp., Booklet, 28 pp. Titled, "What You Should Know About Diesel Engines," it explains in simple, non-technical language with many illustrations, the operation of the simple diesel engine. Compares it with the gasoline engine, and explains the 2 and 4-cycle types.

(23) HERRINGBONE GEAR DRIVES—Link-Belt Co., Bulletin 2519, 36 pp. Detailed information about single, double, and triple reduc-

does

coil-itis* have your processing tank production off its feed?



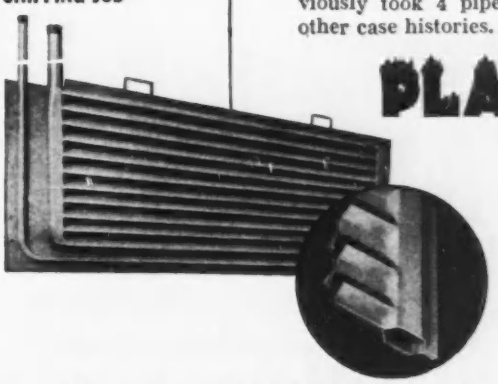
When the appetite for work of your heating and cooling processes diminishes, the trouble may well be coil-itis. For, downtime due to pipe failures and limitations can seriously delay your production flow. Switch to Platecoils, the new tonic for production, as revolutionary as the new wonder drugs. Platecoils take 50% less tank space leaving more room for greater payload. They heat or cool 50% faster. They simplify maintenance and save hours of downtime. Equally important, Platecoils cost as much as 50% less in the first place. Platecoils cure production troubles involving heat transfer and give production a shot in the arm.

Write for Bulletin P77 today!

PLATECOILS SAVE 50% IN HEAT TRANSFER COSTS

PLATECOILS ELIMINATE A 6-TO-8 HOUR-A-DAY CHIPPING JOB

At Sealed Power Corp., installation of Platecoils has completely eliminated a 6-to-8 hour-a-day chipping job. Three Platecoils now heat a tank that previously took 4 pipe coils. Ask about other case histories.



PLATECOIL

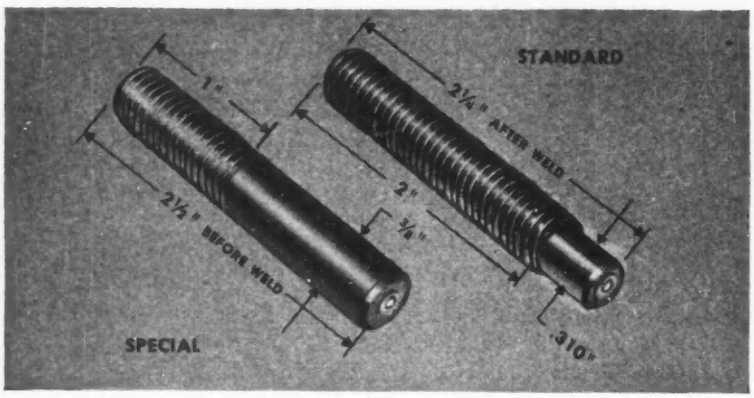
REPLACES PIPE COILS

*Coil-itis — Diagnosed as tank heating and cooling problems. Platecoils — the prescription for solving pipe coil problems.

PLATECOIL DIVISION, KOLD-HOLD MANUFACTURING CO., LANSING 4, MICHIGAN

improved stud welding
through **K S M** engineering

CONVERTING TO STANDARD KSM WELDING STUDS SAVES COMPANY OVER $1300 YEARLY

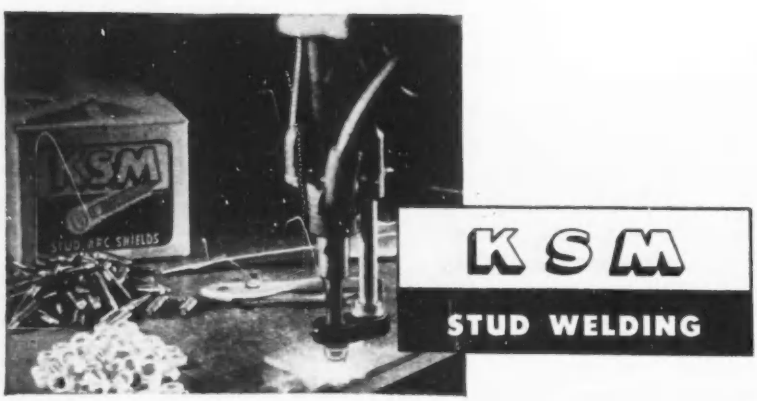


CHANGEOVER IMPROVES WELDABILITY

A study of the special welding studs used by a large manufacturer indicated substantial savings could be made by using standard studs in place of special studs in many applications.

For example, a special 2½" (before weld) by ⅜" stud, threaded 1" was replaced by a standard 2¼" (after weld) by ⅜" stud threaded 2". Every requirement of the special welding stud was met by the standard stud. The savings amount to $13.60 per thousand in quantities of one hundred thousand per year for this one change. Savings from the complete changeover program will amount to many thousands.

How can K S M engineering lower your stud welding costs? Let us investigate without obligation. KSM Products, Inc., Merchantville 8, N.J.



tion enclosed herringbone gear drives in service. Horsepower ratings for input speed of 720 to 1750 rpm are given for all drive sizes, plus complete instructions for correct selection. Lists 39 sizes of drives in 534 standard ratios from 2.84:1 to 326:1. Capacities range from 0.4 to 2480 hp.

(24) ELECTRIC HEATERS—General Electric Co., Bulletin GEC-1005D, 60 pp. Describes the Calrod equipment in terms of application, special features, installation, and pricing. It is indexed by process and application, and contains methods of determining power requirements and heat losses by application. Covers: immersion; strip; cartridge; tubular; insertion; and fin heaters.

(25) FLEXIBLE GEAR COUPLINGS—Sier-Bath & Pump Co., Inc., Catalog C4, 16 pp. Has large exploded and cutaway views of a easily assembled flexible gear coupling in load capacities from 4 to 600 hp per 100 rpm. Has specifications and engineering data for: standard; mill; motor; vertical; floating shaft; and spacer types in sizes ⅞ to 6 inches. Also typical application photos.

(26) FLOW CONTROL VALVE—Airmatic Valve, Inc., Bulletin 4810, 2 pp. Engineering specifications on a flow control valve designed to control the speed of the piston stroke in a cylinder. Available in six standard pipe sizes from ¼ in. to 1¼ inches.

(27) RECTIFIER APPLICATION—American Rectifier Corp., Booklet. Arranged in a question-and-answer style, explaining the application of rectifiers to various operations, and gives the benefits of keeping d-c equipment working on a-c while retaining d-c speed control. Made in sizes from 3 to 1000 KW from 50 to 10,000 v d-c output and either fixed or variable voltage.

(28) SPECIAL ROTATING EQUIPMENT—Electric Specialty Co., Catalog 52-PD, 12 pp. Illustrations of applications of special a-c and d-c motors, motor generator sets, rotary converters, and dynamotors. Also lists factors in the selection of motors.

(29) COMPOSITION OF INDUSTRIAL METALS—Sam Tour & Co.,

For quality control you can be proud of

When you have inspection and quality control procedures you're proud enough of to talk about, they must be good.

These three advertisements were published by firms justly proud of their methods. All three use Kodak Contour Projectors as an example of the type of care they exercise in producing products of uniformly high precision.

Optical gaging with a Kodak Contour Projector provides a fast, accurate method of production measurement and inspection. Operators can get the work out in a hurry—little training is required. Accessories are available to make possible measurement of the most complex shapes.

To see how a Kodak Contour Projector can help you reduce inspection costs, improve quality, send for our new 12-page booklet. It gives you details of both the Model 2A, for precision micrometry, and the Model 3, for fast, routine gaging. For your copy, write to:

Industrial Optical Division
EASTMAN KODAK COMPANY
Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Optical Gaging

A new sound movie, Optical Gaging, shows how to simplify complex inspection problems. We'll tell you how to get it for a showing.

Kodak

TWO MILLION WITHOUT A FAILURE!

parts: small connecting rods

alloy: "600" series metal, a high strength bearing bronze that contains no tin

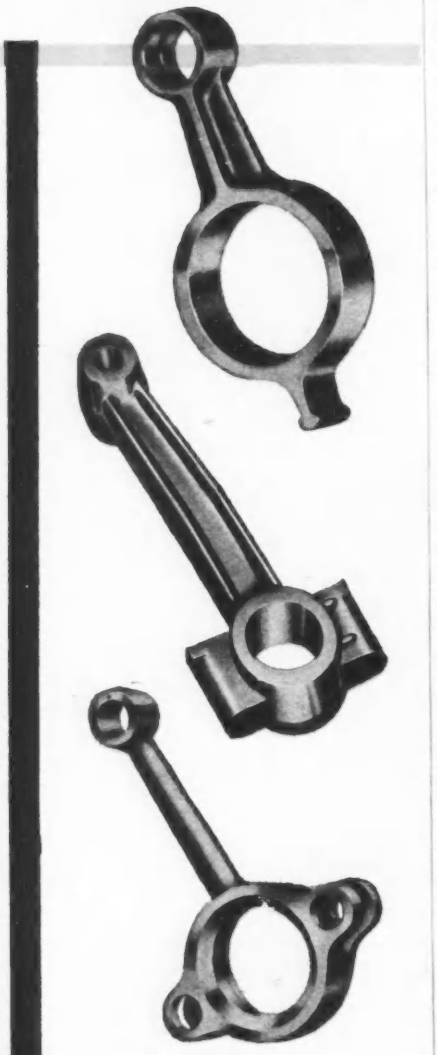
quantity to date: over 2,000,000

number of failures: none

forged by: Mueller Brass Co.

advantages: no bearing insert is necessary on either the wrist pin or crankshaft end because each rod acts as its own bearing. Dense homogeneous grain structure, close dimensional tolerances and high mechanical properties often permit redesigning for weight savings as high as 15% to 25%. "600" alloys have low coefficient of friction, high resistance to corrosion and tensile strength 2½ times greater than cast phosphor bronzes.

uses: compressors, outboard motors, small high speed gasoline engines. Best results are obtained if they operate against hardened, ground and polished shafts.



"600" SERIES ROD is produced in standard 12-ft. mill lengths and a wide range of sizes and special shapes. This rod has a fine, uniform grain structure and the mechanical properties are rigidly controlled in the cold drawing process. Scrap loss is greatly reduced in machining operations because of the complete absence of defects. For complete information, write us today.

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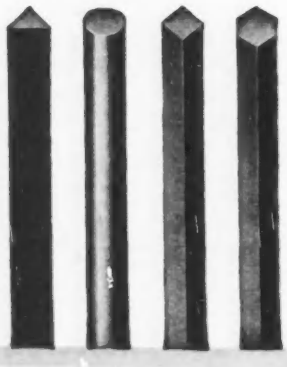


MUELLER BRASS CO.

PORT HURON 17, MICHIGAN

Inc., Chart. Chart lists the constituent elements and the percentage composition ranges for 60 different classes or types of metals arranged in groupings: light metals; irons; steels; cobalts; nickels; coppers; white metals; precious metals; heavy metals; and special purpose metals. Also the atomic number, and the specific gravity of each of the 48 elements commonly encountered.

(30) V-BELT SHEAVES — Fort Worth Steel & Machinery Co., Bulletin 83 gives dimensions and weights of QD v-belt sheaves and hubs. Tables and line drawings give complete hub and sheave dimensions including face width, hub position, hub length, minimum and maximum bore, and dimensions of standard keyway. Construction features described in cutaway views.

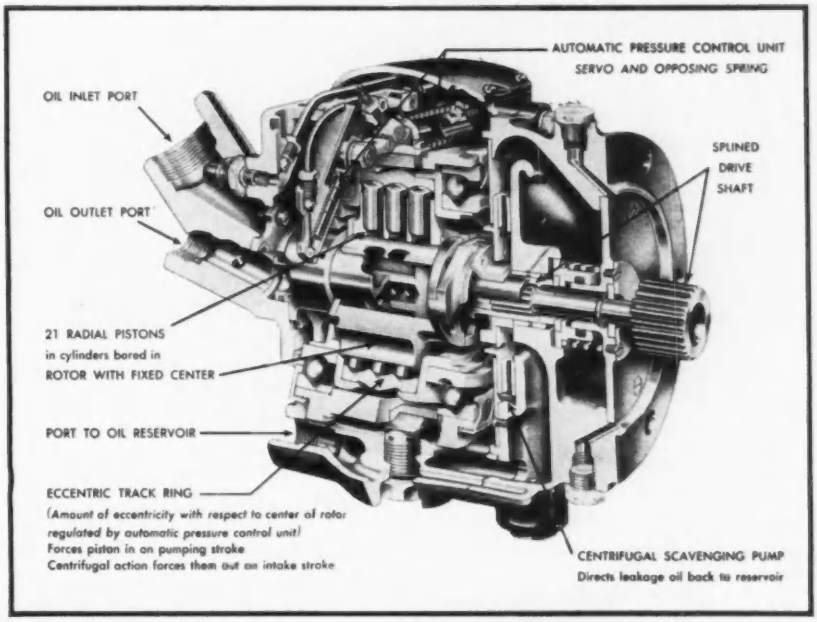
(31) ELECTRONIC COOLING EQUIPMENT—Rotron Mfg. Co., Inc. Catalog 2, 60 pp. Complete information, specifications, operation curves, and other data on a line of cooling devices for electronic equipment. Covers: tube data; blowers; fans; heat exchangers; tube supports; controls; auxiliaries; and application data. Illustrations of all models.

(32) INDUSTRIAL DISK BRAKES —The Goodyear Tire & Rubber Co. Bulletin A1725K, 8 pp. With illustrations it lists the varied applications of the airplane-type disk brake for industrial uses. Can be adapted to most machines, and can be operated hydraulically, mechanically, pneumatically, or can be spring-set, solenoid released.

(33) MINIATURE CONNECTORS —Viking Electric. Catalog, 16 pp. Has engineering specifications and templates of a line of miniature connectors, terminal boards, thermocouple connectors, and printed circuit hardware.

(34) CONTROL VALVES — A-P Controls Corp. Bulletin R, 24 pp. Information on a full line of control valves, including pressure or temperature-controlled throttling and expansion valves, pressure-limiting valves, water-flow regulating valves, solenoid valves, thermo-electric gas valves, and

Can you help design a NEW HYDRAULIC PUMP for tomorrow's planes?


AUTOMATIC PRESSURE CONTROL UNIT
SERVO AND OPPOSING SPRING
OIL INLET PORT
SPLINED DRIVE SHAFT
OIL OUTLET PORT
21 RADIAL PISTONS
in cylinders bored in
ROTOR WITH FIXED CENTER
PORT TO OIL RESERVOIR
ECCENTRIC TRACK RING
(Amount of eccentricity with respect to center of rotor regulated by automatic pressure control unit)
Forces piston in on pumping stroke
Centrifugal action forces them out on intake stroke
CENTRIFUGAL SCAVENGING PUMP
Directs leakage oil back to reservoir

Problem: Modern jet aircraft use hydraulic power not only to actuate landing gear, but also to supplement the pilot's physical strength in moving primary control surfaces when flying at high speeds. Since requirements for this power vary tremendously over widely divergent flight conditions, the pump supplying it must be able to deliver large amounts of oil when needed, and yet operate efficiently with lower power absorption at other times. It also must provide high volumetric efficiency at high speed to avoid cavitation.

Our Answer: A compact, 22-pound unit capable of operating at higher speeds than other commercially developed pumps. The Hamilton Standard variable displacement pump automatically adjusts its flow to meet the requirements of constantly changing flight conditions. It delivers twenty gallons per minute at 6300 rpm yet embodies an automatic stroke control which reduces the oil flow to zero at 3000 psi. Since pistons are filled by centrifugal action, pump is free from cavitation at high speeds.

What's Your Answer? Hamilton Standard's pump is operating with high efficiency in today's jet aircraft. But tomorrow's even faster planes will demand different ideas and designs — completely new hydraulic units.

This is just one of many challenging engineering projects at Hamilton Standard. In addition to pumps, our growing line of jet aircraft equipment already includes turbine engine starters, fuel controls, cockpit cooling systems, auxiliary drives and other as yet "classified" products. There are also many exciting new developments in world-renowned Hamilton Standard propellers.

Creative Engineering Pays Off at Hamilton Standard

A majority of our company executives are engineers, quick to recognize the value of sound, creative ideas. We have an exceptionally able technical staff now — but we need more experienced designers to meet the demands of the largest research and development program in our 33-year history. If you can help us in this expanding program, there's interesting work and a wonderful opportunity awaiting you at Hamilton Standard.

There's a Future at Hamilton Standard

for Designers

with 3 to 10 years' experience in actual design of mechanical parts (not necessarily in aircraft field — machine tool, electrical, automotive or automatic machinery could be just as valuable). Engineering degree helpful, but not necessary if practical experience is adequate. Knowledge of mechanics, mathematics, strength of materials, thermodynamics or hydraulics would be desirable but *experience in machine design is the essential requirement.*

for Analytical Engineers

with an engineering degree and at least 2 years' actual experience as design analysts. Knowledge required either of mathematics, mechanics and strength of materials, or of mathematics and thermodynamics.

These Positions Offer

- Excellent pay and a fine chance for advancement based on ability.
- Opportunity to use your education to the fullest extent on a wide variety of problems.
- Association with exceptionally high calibre engineering staff — with freedom of decision and responsibility.
- Ideal location with every cultural and recreational advantage — midway between Hartford, Conn., and Springfield, Mass.
- New plant with modern air conditioned offices in a beautiful country setting.
- Secure future with a progressive company whose engineering staff has grown steadily for 33 years.

Send resume of your experience to

Engineering Representative
Personnel Dept., Section B

Hamilton Standard

Division of United Aircraft Corp.
Windsor Locks, Conn.

HILLS-McCANNA

FORCE FEED LUBRICATORS

protect vital bearings in your product

Solve the vital bearing lubrication problem in your product with a Hills-McCanna Force Feed Lubricator. Two basic models ("ET" and "MB") are offered that assure the user of your product of positive, dependable lubrication control.

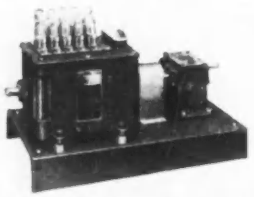
Hills-McCanna model "ET" lubricators are fully enclosed units suitable for installation under virtually any condition—indoors or out. The pump valve is the positive action, single plunger type. Model "ET" is built in sizes ranging from 2 pint, 1 feed to 32 pint, 24 feed.

Hills-McCanna model "MB" lubricators are the open type preferred by many because of the simplicity of design and the accessibility of all working parts. Model "MB" is built in sizes ranging from 2 pint, 1 feed to 24 pint, 48 feed.

Where desired, either model is available with dual reservoirs for handling two types of oil through the same lubricator assembly. Either model is available with a variety of drives to simplify application on almost any product.

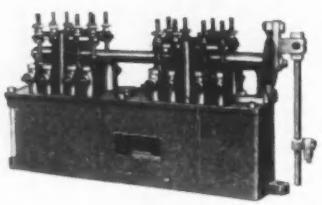
For full details, write to Hills-McCanna Company, 2444 West Nelson Street, Chicago 18, Illinois.

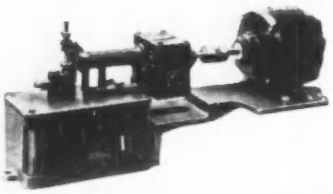
"ET" Enclosed type 8 pint, 6 feed unit.



"ET" Enclosed type 8 pint, 6 feed unit with external gear reducer.

"MB" Open type 12 pint, 16 feed unit.





"MB" Open type with lubricator motor driven through gear reducer, 6 pint and up capacity.

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custom valves for special applications. Has complete mechanical and electrical specifications.

(35) TUBE FITTINGS—The Imperial Brass Mfg. Co. Catalog 3500, 74 pp. Illustrations, description, and specifications for a line of tube fittings for connecting copper, brass, aluminum, steel, and other metal tubing. Covers all pipe fittings, flexible hose and attachable fittings, valves, faucets, drain cocks, strainers, and others.

(36) RIGHT ANGLE GEAR DRIVE—U. S. Electrical Motors, Inc. Bulletin F-1775-60m, 8 pp. Describes in detail a new Holloshaft gear drive to operate vertical turbine pumps where electricity is not available. Full page, color cutaway view shows all the features.

(37) INDUSTRIAL X-RAY—Westinghouse Electric Corp. Catalog 404-000, 44 pp. A guide for a complete line of accessories and supplies required for the industrial x-ray installation. Divided into four categories: films and chemicals; radiographic accessories; dark room accessories; and viewing and filing equipment.

(38) MAGNETIC MOTOR STARTERS—Arrow-Hart & Hegeman Electric Co. Bulletin 4529-26, 8 pp. Describes the new RA-V magnetic motor starters with vertical overloads below contactor. Available in NEMA sizes 0 through 5. Uses described. Design features illustrated. Size, weight, and other engineering data included.

(39) ELEMENTS OF WELD DESIGN—The Lincoln Electric Co. Bulletin 843B, 17M, 6 pp. Lists steps for the designer to follow in shaping steel for low cost. Compares cost of cast parts to welded steel parts. Has illustrations of different parts that were reshaped with reduction in weight and increased strength.

(40) ROTATING MECHANICAL SEAL—Durametallic Corp. Bulletin 455, 12 pp. Presents data on applications, plus large cutaway views of a mechanical seal that rotates with the shaft, and is designed for use with centrifugal and rotary pumps, autoclaves, agitators, blowers, and other rotating equipment.

Sans, Souci

Ad Libbing by the Editor

A short editorial is not enough to present in detail the situation that the national engineering societies are facing with reference to the question of their participation or nonparticipation in political affairs.

Material civilization is marching onward. It is getting extremely complex. Two hundred years ago when world civilization was primarily agriculture and there was little engineering, there were not many engineering problems in the conduct of our national affairs. Gradually the picture changed. Production machinery, vehicles of transportation and communication, and our vast industrial empire have changed the picture tremendously.

When the American Society of Mechanical Engineers was born we had no radio, no movies, no automobile and no mass production as we know it today.

The founders of our engineering societies were the great leaders of industry of their day. They were great men. Quite properly they realized that if these engineering societies were to become tangled in questions of politics the result could well be dissension within the society and schism. Indeed, there was relatively little that engineers could do that lay citizens could not do in solving the political problems of that day. It was perhaps well that the great engineering societies kept themselves entirely clear of politics in those early years.

Today the picture is entirely different. The building and manufacturing and service industries dominate the activities of the country. Even the agricultural industry is no longer purely agriculture as it was known one hundred years ago. Food processing, packaging and distribution have become an engineering problem rather than an agricultural one.

Every advance of engineering adds another batch of problems. Hundreds of thousands of laws have been passed regulating the automobile, the railroad, communications systems and all of the other national activities that stem from science and engineering. It has also been necessary to create

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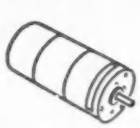
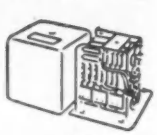

Motor, Generator, and Gear Train Combinations


Servo Amplifiers

many politically appointed bodies or commissions to administer the regulations and the laws concerning the various industries. Thus we have the Communications Commission, The Interstate Commerce Commission, The Bureau of Mines and many similar bodies.

In addition to the regulatory bodies, it has also been found desirable or necessary to establish various laboratories which are devoted entirely to engineering experimenting and testing, all for the public welfare. In addition to the well known Bureau of Standards we have the laboratories of the Bureau of Mines, the Forest Products Research Laboratories, the great experimental laboratory of the Bureau of Reclamation and many others. All of them deal with basic engineering problems.

To the best of my knowledge none of the national engineering societies are organized to take any action of any kind regardless of what may happen in government in matters that are basically engineering. The "Astin affair" could occur at each and every one of the laboratories mentioned and none of our national societies would be prepared to take swift action.

Carlton S. Proctor, past president of the American Society of Civil Engineers, has pointed out the great need for greater participation by American engineers in the running of the country. Indeed, this is a favorite topic of discussion at many gatherings of engineers. But as long as they follow their tradition, the engineering societies will simply keep their hands off national problems that in any way involve politics. The societies are hidebound by tradition that should have been discarded long ago.

The Bar Associations are extremely active in political affairs. In many instances the candidates for appointment to judgeship must be passed upon and approved by the Bar Association.

When socialized medicine was being pushed by the Democratic administration in Washington the American Medical Association sprang into action with no delay. Regardles of whether or not socialized medicine is good or bad the fact is the medical profession acted on a political problem that affected them greatly. Whoever heard of the ASME or any other national

engineering society being asked to pass upon the acceptability of a candidate for appointment to political office? Who has ever heard of any of our national engineering socieities taking action of any kind on any great national issue which was basically and fundamentally a problem of engineering? The Astin case devastatingly demonstrates the impotency of our big national engineering societies. It is high time for a change. We need more men like Carlton S. Proctor occupying the high places in our engineering societies.

The Shortage of Engineers

One activity in which the engineering societies are very much in the limelight is that of erasing the shortage of engineers. Of course we should have enough engineers and if there is a genuine shortage of engineers something should be done about it. But the fact is that the efforts of many of the graduate engineers are being wasted by the failure to use them in the biggest jobs that they can handle. One of the maxims of the late H. L. Gantt was that every man should be given the biggest job that he is able to handle. I would like to add to that the thought that every man should be given working conditions and assistance to enable him to do the best and most work.

It is notorious that few engineers have private secretaries. It is usual to find the engineers sharing secretaries or having none at all.

Naturally, the first question is, "Does an engineer have use for a secretary?" Some do and some don't. But I have noticed that many engineers, whose work could unquestionably be vastly expedited if they had a secretary, had to do as well as they could without a secretary.

In addition to the question of secretaries there is also the question of proper working quarters and proper equipment and tools. Many engineers do not have a private office. They are supposed to do "million dollar thinking" in a "bull pen." Naturally their volume of production suffers; so does the quality. Here again is a place where a more effective use of engineers will greatly offset the shortage.

Whether there be a real shortage or no shortage, the fact is that there is not a glut of engineers. We can all say hurray because this has resulted

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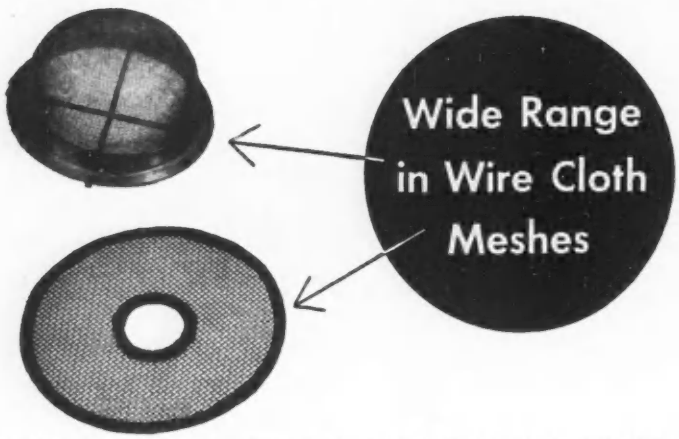

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in the engineer getting almost as much as a teamster or a skilled mechanic. Between $350 per month and $400 per month seems to be the starting salary for the 1953 model of engineering graduate. That's fine. And as long as engineering is a commodity the price of which goes up and down with supply and demand, so let there be no abundance of engineers.

I am just wondering what our engineering societies would do if their efforts to wipe out the "shortage" of engineers succeeded and we had a glut of engineers with a resultant drop in salaries. Would the American Society of Mechanical Engineers do anything about it if the salary of an engineer dropped to a point where it was half the wages paid to a teamster? Should the young engineers support a society which exerts itself in a major fashion to pull down his earned income and does absolutely nothing to improve his economic status? The only sensible answer is to become extremely active in that society and wipe out its stodginess and shortcomings. —G.F.N.

Electronic Aptitude Tester

THE PERSONNEL DEPARTMENT of the future may well be a maze of germanium diodes and vacuum tubes. At least the first big step in that direction is a "robot psychologist" developed by GE for the U. S. Army to make certain that the right man gets the proper billet.

At present, the two and one half ton, double section electronic computer, known as a psychological matrix rotator, is being used to facilitate studies designed to improve current methods of mass psychological testing. Primarily developed to handle statistical data representing 12 different abilities underlying up to 50 tests, the computer can be expanded to handle much larger personnel problems.

The machine's use in a typical application might run as follows: paper and pencil tests are given to various "known" groups of people, and the results are fed into the computer after being translated into statistical form. Then, the machine flashes test data upon a screen as a pattern for comparison with random groups.

ENGINEERING ABSTRACTS

Glass Bonded Mica In Electrical Design

Abstracted fom "Glass Bonded Mica" by J. H. Dubois, Mycalex Corporation of America, *SPE Journal*, April, 1953.

OF THE AVAILABLE MATERIALS suitable for high temperature and high frequency use, glass bonded mica has the best balance of properties for products requiring structural precision insulation. Its good balance of properties: moldability, precision dimensional stability, low thermal expansion differentials, low electrical loss, zero moisture absorption, high temperature stability, and arc resistance. These properties have extended the use of glass bonded mica products in competition with new materials including the new organic plastics which have provided partial answers to many of the high temperature, frequency, and voltage requirements.

Tetrafluoroethylene, for example, has an extremely low loss factor, excellent arc resistance, high dielectric strength, nil moisture absorption, but being slightly elastic, cannot be produced with dimensional precision and is distorted under pressure. It cannot be used conveniently as a structural part in many cases which require superior electrical properties, because of its low heat distortion point and its poor corona resistance. Trifluorochoroethylene has good electrical properties, nil moisture absorption, is quite stable dimensionally under exposure conditions, but has a low heat distortion point and may not be used structurally when stressed at elevated temperatures; like the other organic plastics, it also lacks corona resistance. Steatite, a ceramic, has a very high heat distortion point, good electrical properties, nil moisture absorption, but cannot be produced economically with tight dimensional control and is very poor in thermal shock resistance.

Electrical insulation dielectric breakdown is caused by heat, resulting from nearby radiant sources and from internal electrical losses. Power losses increase with temperature, frequency, voltage, moisture content, and oc-

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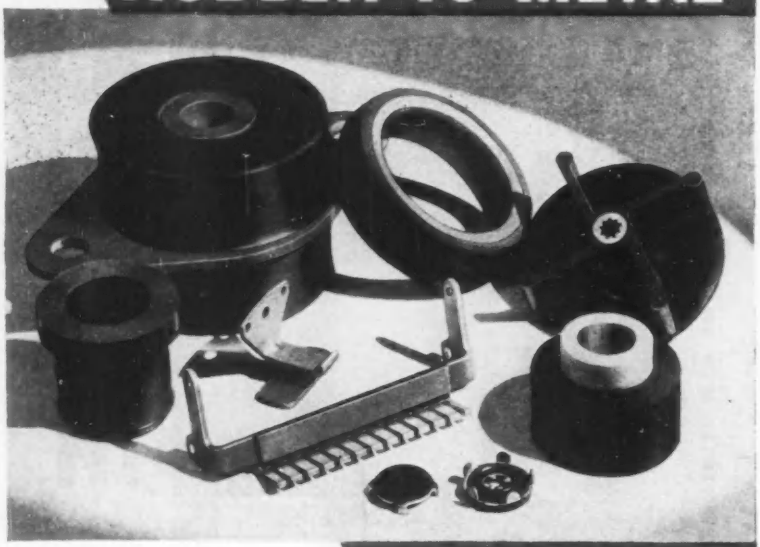

As a result of modern compounding, molding and adhesion techniques, many of which were developed in the Acushnet laboratories, the best properties of metal and rubber can be combined in one bonded unit to obtain strength, toughness and resiliency, as well as shock and vibration absorption, sound abatement, electrical insulation or conductivity, corrosion and abrasion resistance, and other desirable advantages.

Acushnet's specialization in this relatively new field involves the adhesion of rubber or synthetic rubber to metal in molds designed to accommodate the metal parts and which, in addition to bonding the rubber material to the metal, form and vulcanize the rubber in the same operation.

With extensive equipment and facilities for solvent degreasing, sandblasting, cementing and brass plating, Acushnet bonds rubber to metal by several processes, each suited to a particular application for the most efficient adhesion. Our engineers will gladly study your prints and make prompt recommendations.

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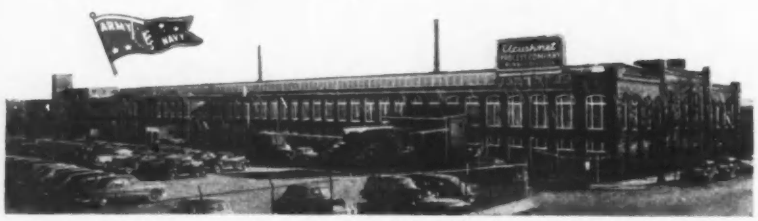

Address all communications to 768 Belleville Ave., New Bedford, Mass.

cluded gases. Thus, low power losses require insulating materials which have no moisture absorption and are free of internal voids.

Glass bonded mica products absorb no moisture or gas, maintain the tightness of inserts as temperatures rise, and hold fairly low power losses over the operating temperature range. Insulators having a high dielectric constant but low loss factor are particularly desirable in high voltage, high frequency apparatus because the stress concentration around the metal insert is more easily dispersed; this factor explains why tetrafluoroethylene, trifluorochlorethylene and other low dielectric constant insulators sometimes fail when glass bonded mica stands up. Many plastic materials fail in low loss applications because of their high thermal expansion coefficients which introduce an air gap between the insert electrode and the insulator, as temperature change brings on the large differential expansion. Glass bonded mica provides the designer with a useful product combination because of its low differential expansion rate when molded with inserts.

Table I shows that glass bonded mica and 446 stainless steel match very closely, and it is possible to produce tight inserts over a large temperature range with many of the metals listed. Glass bonded mica components may be cemented directly to the ferrites and certain metals with no thermal loosening as a result of the closely matching thermal components. Parts with inserts, as molded, may be gas tight, and one high pressure electrical seal has been tested and

Table I—Thermal Expansion Coefficients of Glass-Bonded Mica and Insert Metals

Materials	Thermal Expansion Coefficient $\times 10^{-7}$/C
Platinum	88
Illium R	92
Glass-Bonded Mica	100
Type 446 Stainless Steel	105
Inconel	115
"430"	118
SAE 1010 Steel	121
Nickel	130
Monel	140
18-8 Stainless Steel	160
Copper	177
Nickel Silver	180
Red Brass	188
Silver	191

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This will give you the idea that Thompson knows a great deal about special alloys to operate at high temperatures... under tougher-than-usual conditions.

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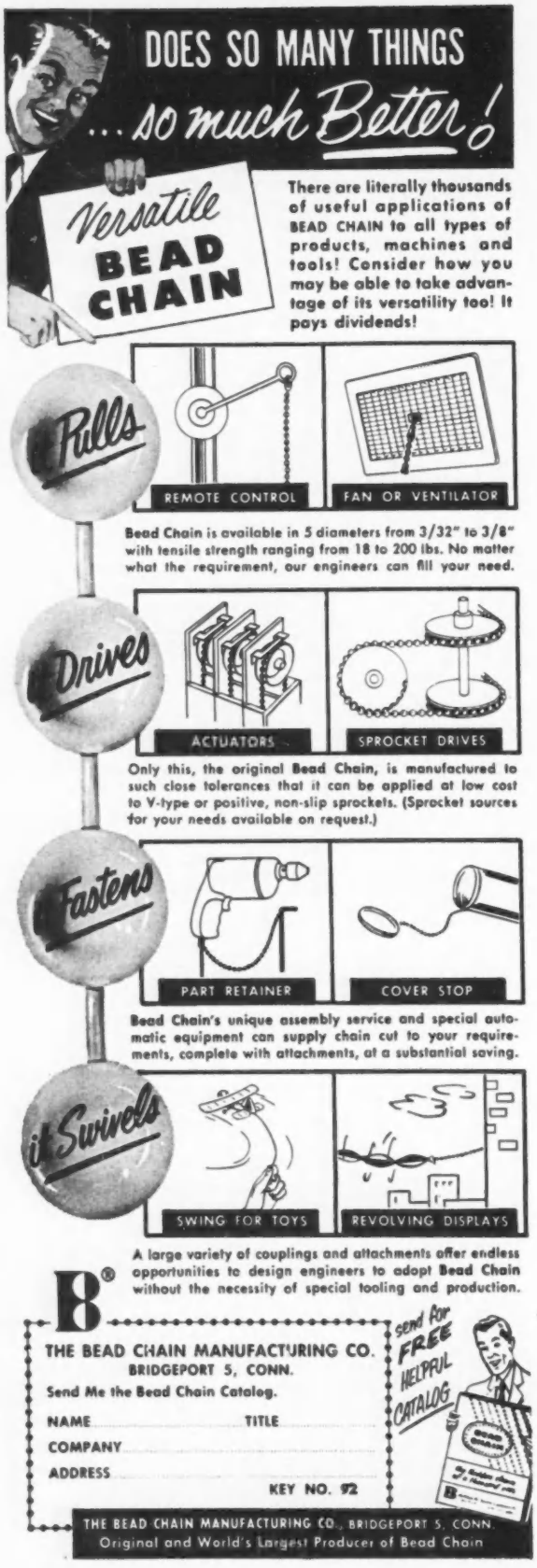
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found to withstand fluid pressures of 350 lb with no leakage along the inserts; with a secondary treatment, this same seal withstood fluid pressures up to 2,500 psi. Hermetic seals with excellent thermal shock resistance have been produced in the laboratory.

The miniaturization programs of the Signal Corps, and the fast growing demand for structural and functional components demanding even higher firing temperatures for the printed circuit silver pastes, have initiated the development of glass-bonded synthetic mica. Both natural muscovite mica and natural phlogopite mica, used for conventional glass bonded products, have hydroxyl ions in their crystal structure which precludes their high temperature use. The synthetic mica, fluorphlogopite, has no hydroxyl and can be heated to 2,000 F for several hours. Natural micas bloat and lose strength far below this elevated temperature. The top safe limit for natural micas ranges from 1,000 to 1,500 F. Whereas there is no material on the market with good electrical properties at 900 F, glass bonded synthetic mica has a low loss factor at this high temperature. A most important gain is increased refractoriness; printed circuits have been fired on glass bonded synthetic mica at 900 F with no floating or distortion. A glass research program has been initiated to develop a suitable glass that will measure up to the high temperature potentialities of synthetic mica. Since the synthetic mica top limit will exceed the temperature limitations of mold steels, the glass temperature research program is being confined to the range in which steel molds can be maintained in precisional dimensional control. Current molding practice makes use of preheating at 1,300 F and mold temperatures of 800 F. The glass requirement for synthetic mica must fall in the "low" temperature range (1,500 F) have excellent electrical properties, and be highly resistant to water vapor.

Synthetic mica is also being evaluated as a filler for tetrafluoroethylene and trifluorochloroethylene. Filled organic plastics in general exhibit substantial variation in loss factor and dielectric constant. Pure synthetic mica which may be molded at high temperatures and is free of combined moisture produces a good low loss compound with improved dimensional stability.

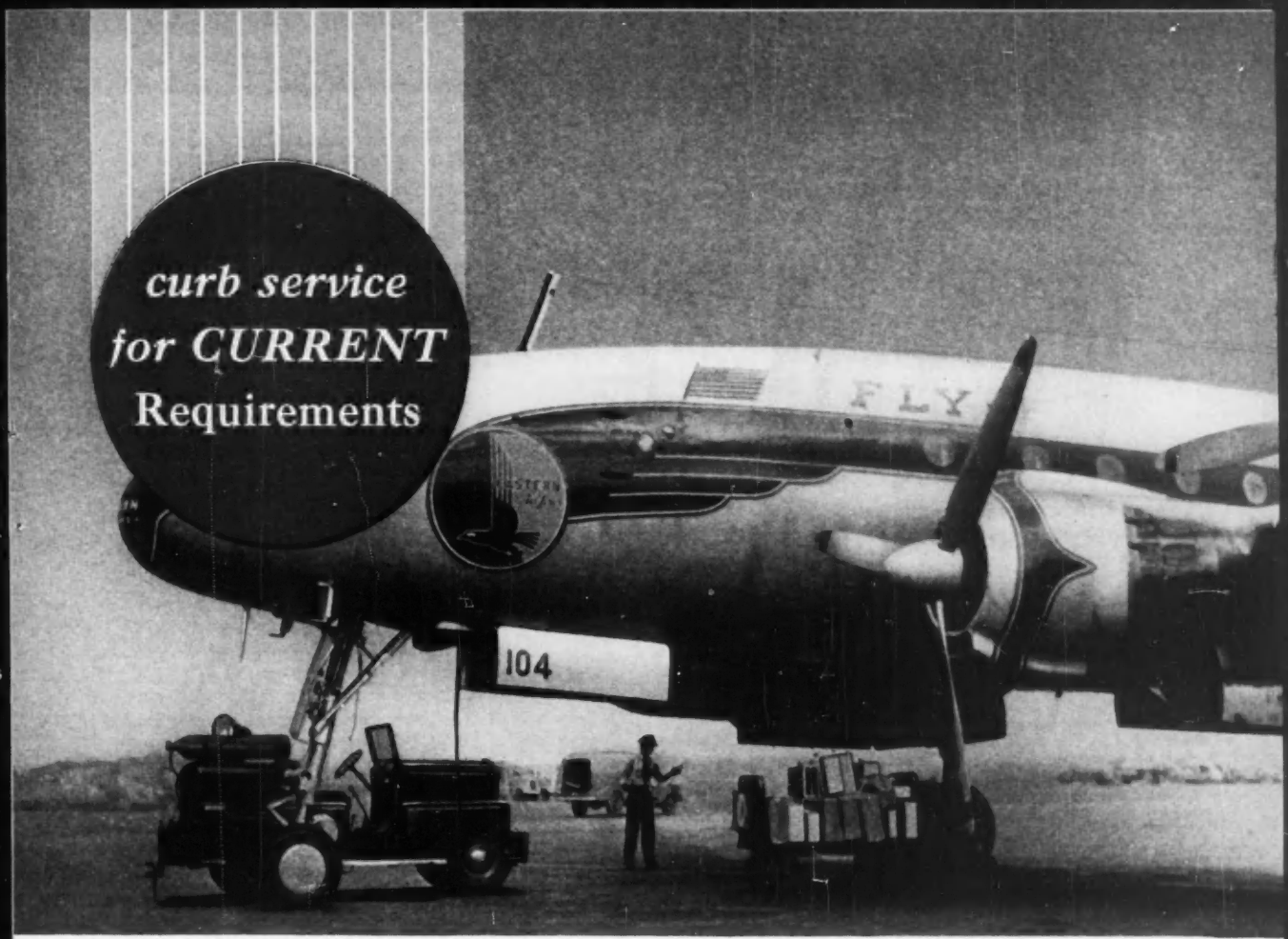
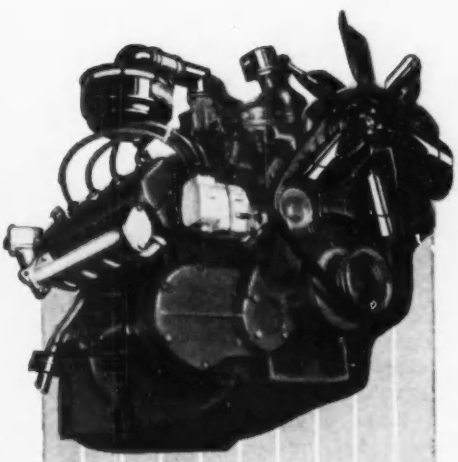


Photo courtesy Hobart Brothers Company, Troy, Ohio

Chrysler horsepower on the ground for added Safety in the Air . . .



The moment the big plane stops and the pilot cuts the engines, the generators, which in flight supply electrical power to the batteries, stop too. But the electrical equipment in the plane—air conditioning, lights, radio, food containers, everything electrical—continue operating off the plane's batteries. Only for a moment, however. In that length of time a self-propelled and self-powered energizer takes over and supplies all necessary current, even starting the plane's engines when it's time to leave.

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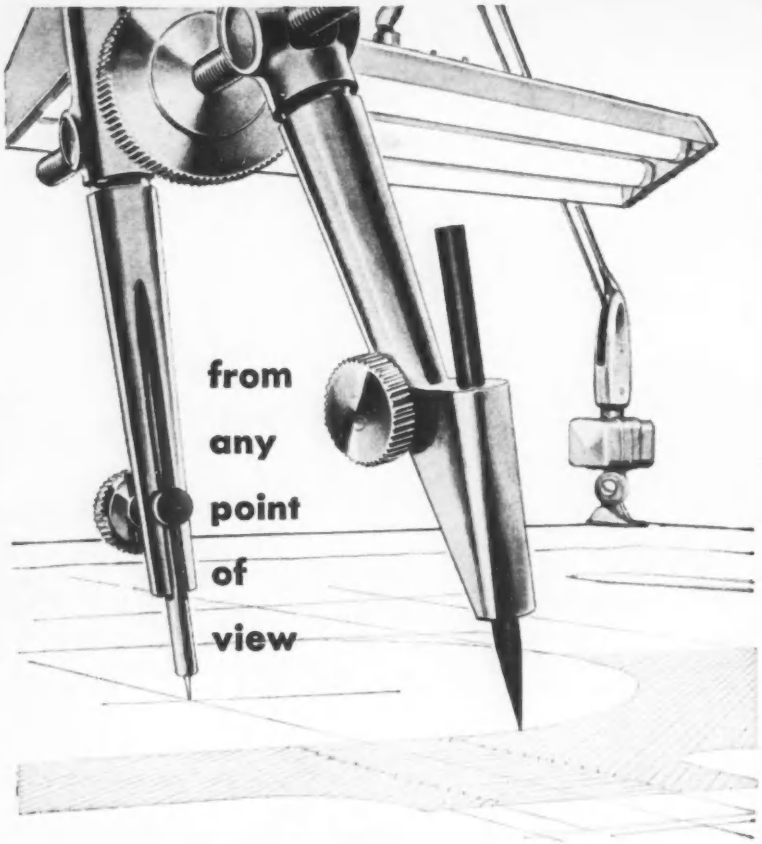

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Aluminum Aircraft Alloys

Abstracted from "Aluminum Alloy Family Gets New Quartet" by J. A. Nock, Jr., *SAE Journal*, March, 1953.

AMONG THE NEW AND BETTER MEMBERS that are constantly being added to the family of aircraft aluminum alloys are: Thinner and higher strength aluminum coatings: and rivets of higher shear strength.

Cladding thickness is usually fixed at a certain percentage of the total thickness of the sheet or plate that is to be given this electrolytic protection. With the heavier sheets, however, coatings often become thicker than necessary, thus adding unnecessary weight. For example, in Alclad 24S, cladding is a nominal 5 percent on each surface of 0.063 in. or less thick sheet, but only 2½ percent on each surface of sheet 0.064 in. or more in thickness.

On Alclad 75S sheet, cladding was formerly fixed at 4 percent on each surface for all thicknesses. Recent developments in the methods of applying thin coatings now make it possible to offer Alclad 75S sheet and plate in thicknesses from 0.188 to 0.50 in. with a coating thickness of about 1½ percent on each surface. This thinner coating provides ample electrolytic protection to 75S-T6, removes the weight penalty of excess cladding, and results in increased strength.

This new material may be of interest if fatigue becomes a problem in the use of high-strength clad sheet. In the meantime, more detailed evaluation of the material must be completed before it can be considered commercially.

Aircraft rivets with higher shear strength than that of the commonly used 24S rivets are another newcomer. Made of 75S-T6, the shear strength of these new rivets is about 48,000 psi, which is 15 percent better than the 42,000 psi of 24S-T31 rivets.

Rivets of 75S in aircraft sizes are capable of developing shearing strengths of about 54,000 psi when

heat-treated at 860 to 920 F and aged for 24 hours at 250 F. But driving at room temperatures cannot be accomplished without severe shear cracking of the driven heads.

Satisfactory room-temperature driving characteristics can be obtained, however, by giving the rivets a two step aging treatment consisting of 3 hours at 250 F and 3 hours at 325 F. With this treatment, however, while the resulting shear strength may be as much as 52,000 psi, the rivets do show some susceptibility to stress-corrosion cracking.

In studying this problem, some investigations have concentrated on developing the maximum in shear strength and in overcoming the troubles of driving at room temperature by driving rivets warmed to about 300 F. This method shows promise of overcoming head cracking during driving, but susceptibility to stress-corrosion cracking still exists.

Recently, 75S-T6 rivets aged by a step-treatment have been developed with a shear strength of about 48,000 psi. Since the rivets have a T6 temper, there is no need for solution heat-treating before driving or for refrigerating after quenching to preserve the driving characteristics.

Evaluation of Synthesized High-Temperature Lubricating Fluids

Abstracted from "The Development of High Temperature Hydraulic Fluids" by J. C. Mosteller and J. A. King, Wright Air Development Center, Air Research and Development Command, Dayton, Ohio. Presented before SAE National Aeronautic Meeting, New York, N. Y., April 20-24, 1953.

HYDRAULIC FLUIDS presently being used for systems operating in the temperature range between —65 F to about 450 F are inadequate since no one fluid meets the physical requirements of a high temperature hydraulic fluid. Because of the deficiencies of these currently used fluids, the U. S. Air Force Research and Development Command at their Wright Air Development Center conducted a study of synthetic materials which was aimed at selecting a compound that would possess a majority of the properties desired.

Organo-Phosphorus Compounds. These compounds have reduced flam-

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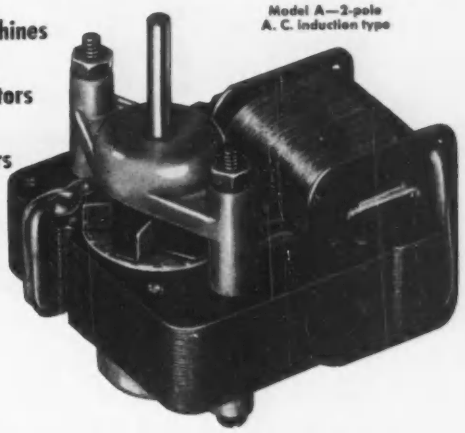
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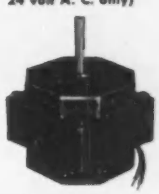
Model D—4-pole A. C. induction type

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It's because hard rubber is far more than "just a good insulator" that it's used in so many electrical parts. The familiar red magneto part above, for instance. It had to be wear-resistant and strong at 300° heat . . . and easily moldable with 17 inserts . . . in addition to high arc resistance (248) and high dielectric strength (600 v/mil). It's Ace Super Magnon hard rubber.
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mability and good lubricating properties. Their viscosity-temperature characteristics equal to highly refined petroluem stocks are superior in volatility properties. Viscosity properties rival those of silicates but are inferior to those of silicones. Dihexyhexane phosphonate and the benzene phosphonate compounds require additives to thicken to the required viscosity at high temperatures. Additives are also needed to impart oxidation and hydrolytic stability. However, the phosphonates exhibit poor thermal stability for extended use in the presence of metal catalysts.

Dicarboxylic acid esters. These esters exhibit lubricating properties approximately those of mineral oil base fluids, but are superior in viscosity-temperature and viscosity-volatility characteristics. They possess high flash points combined with low pour points, and good thermal stability. When properly inhibited, they are non-corrosive to metals. To meet the viscosity requirements of a high temperature hydraulic fluid, the mono and dicarboxylic acid esters require the use of a suitable viscosity index improver. Materials of the type di-2-ethylhexyl sebacate, isooctyl azelate or isooctyl adipate show promise in the high temperature fluid development program.

Carbonates. The viscosity-volatility and viscosity-temperature characteristics of the carbonates are superior to the petroleum base stocks. However, the dialkyl and cyclic carbonates prepared from low molecular weight alcohols or glycols are not sufficiently stable in the presence of water. Partial decomposition takes place producing alcohols, glycols and carbonic acid. Attemps to reduce this hydrolysis by preparing the carbonates from alcohols having from 10 to 16 carbon atoms have resulted in compounds having too great a viscosity and poor thermal stability.

Borates. These materials show better viscosity-temperature characteristics than the petroleum base stocks. But their poor hydrolytic stability prohibit their use as high temperature hydraulic fluids.

Polyglycols. The polyalkylene glycols and derivatives are a possible source for high temperature fluids. But their poor thermal stability over prolonged usage in the presence of metal catalysts is a serious objection to their

The FIRST MODEL

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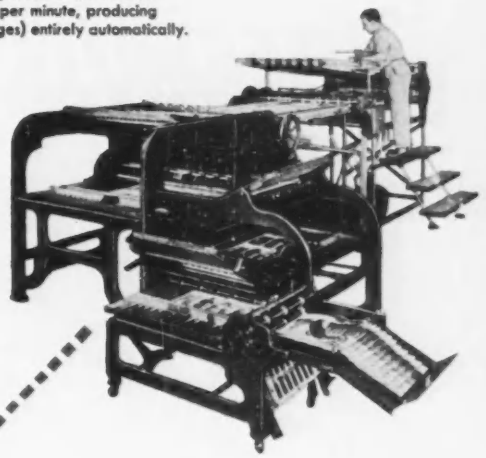
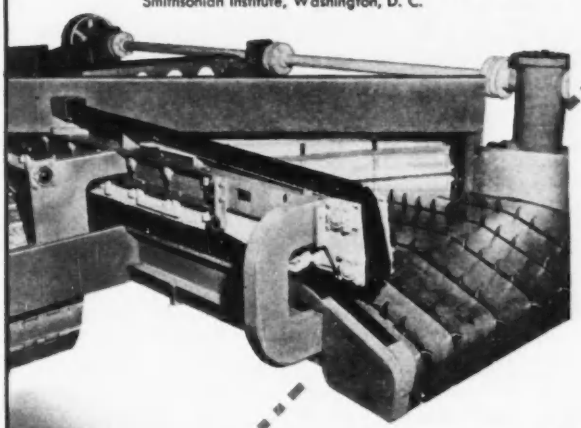


A RAMIE DECORTICATING MACHINE built by SEMCO, showing a "business end" view of the mobile unit that produces raw fibre from the fibrous RAMIE plant used for weaving into textile. Pictures of this machine in operation are considered of historical interest and are displayed in the Smithsonian Institute, Washington, D. C.



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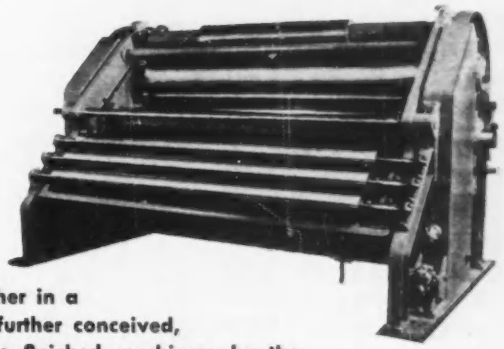

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T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

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Streamlined construction of the new T-J Cylinders *eliminates tie rods . . . reduces head size . . .* and *saves up to 40% in mounting space!* In addition, a new high in strength is achieved with solid steel heads and heavy wall seamless steel body . . . leakproof construction . . . extra high safety factor.

Cylinder walls are precision honed and hard chrome plated for long-life efficiency. Available with the new T-J Super Cushion Flexible Seals which insure positive cushion with automatic valve action for fast return stroke. Many standard sizes and styles . . . both cushioned and non-cushioned . . . for wide range of pushing, pulling, lifting, clamping or control jobs. T-J dependability. *Fast delivery* to meet rush requirements. Write for bulletin 8152. The Tomkins-Johnson Co., Jackson, Mich.

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use. These materials exhibit good lubricating qualities, viscosity-volatility characteristics and viscosity temperature relationships. The use of suitable thickening agents is needed to meet the requirements of a high temperature lubricating fluid.

Silicates. Compounds such as tetra-2-ethylhexoxysilane and tetra-2-ethylbutyoxy silane, dimers and higher polymers show better viscosity-temperature, and viscosity-volatility characteristics than for a petroleum stock and approach those of the polysiloxanes. These materials are stable to shear and when properly inhibited, to oxidation and hydrolysis. Either polysiloxanes or the "Acryloids" are good viscosity index improvers and produce blends meeting the viscosity requirements of high temperature fluids. Further research is needed to determine the flash point and high temperature stability of these materials.

Polysiloxanes. Compounds of this class represented by the polymethylsiloxanes and possibly the polyethylsiloxanes have excellent viscosity-temperature and viscosity-volatility characteristics for use as high temperature fluids. Several polymers of this class show good thermal stability as well as resistance to shear and oxidation. Flash and pour points are within the desired limits. However, the property of lubrication to steel-on-steel sliding and rolling surfaces under large loads is not present in the polysiloxanes. But blending of these materials with other lubricants may result in a satisfactory lubricant.

Halogen containing organic compounds. Materials in this group are the chlorine, bromine and fluorine containing organic compounds, and mixtures of bromine, chlorine and fluorine within the same organic structure. In general, the chlorine and bromine containing organics are toxic, exhibit poor stability, and are limited in high temperature stability applications. The fluorocarbons and the chlorine and fluorine containing organic compounds exhibit excellent resistance to chemical attacks, oxidation, hydrolysis and heat. But the fluorine compounds have poor viscosity-volatility and viscosity-temperature characteristics. This factor prohibits their use in high temperature work where a —65 F requirement exists.

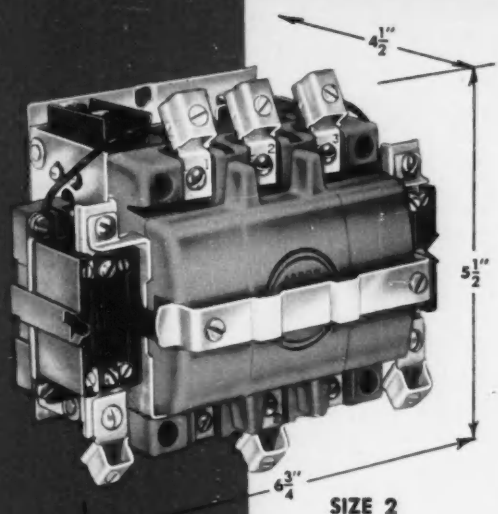
According to recent development

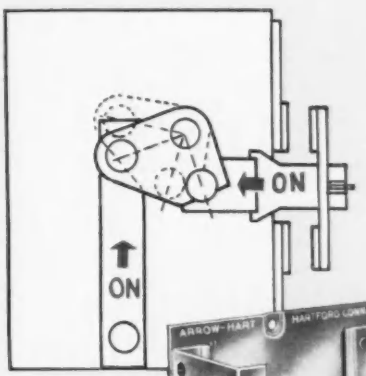
HERE'S THE **BIG STORY** BEHIND

ARROW-HART'S DEVELOPMENT

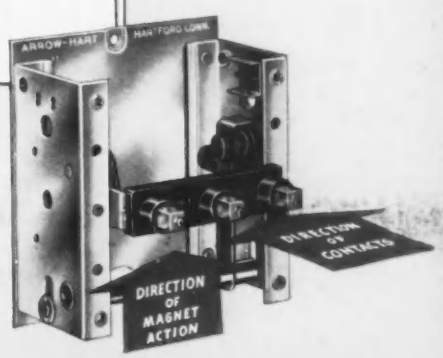
OF THE TYPE "RA"

MOTOR CONTROL DESIGN





Balanced mechanism features knee-action bell-crank fulcrum design to transfer action from vertical to horizontal plane. Action multiplies leverage — increases contact pressure.



JUST ½ THE SIZE

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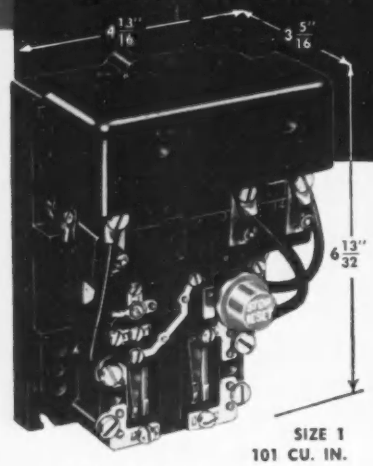
A REVOLUTIONARY DESIGN
THOROUGHLY TESTED AND PROVED TO
PROVIDE SUPERIOR OPERATING PERFORMANCE
IN HALF THE SPACE • WITH LESS WEIGHT

PROGRESS IN DESIGN MAKES THE BIG DIFFERENCE

HERE ARE THE FACTS OF THE ARROW·HART ADVANCEMENT OF *Magnetic* MOTOR CONTROLS



SIZE 1
101 CU. IN.

ARROW-HART'S 1930
CLAPPER TYPE STARTER

COMPACTNESS
Much wasted space; contacts over magnet . . . overload relays below.

UNDERVOLTAGE RELEASE
POOR — dependent on gravity working through an inefficient linkage angle.

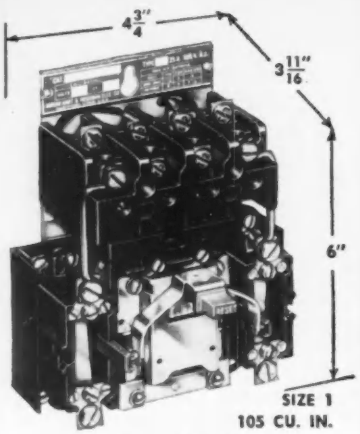
CONTACTS
Single break type.

AUXILIARY ELECTRICAL INTERLOCKS
Available, but could not be added conveniently.

CONTACT ALIGNMENT
No positive guidance, no sure alignment.

WIRING
"Scrambled Wiring" with load terminal on line side and crossing circuits. Difficult to wire and lacking the safety factor of circuit separation.

ARC SUPPRESSION
FAIR but lacking complete separation of arcing chambers. Hood and base of Bakelite — best material available *then*.



SIZE 1
105 CU. IN.

ARROW-HART'S 1940
DIRECT-ACTING SOLENOID TYPE STARTER

COMPACTNESS
Some improvement, but still far from ideal.

UNDERVOLTAGE RELEASE
Still entirely dependent on gravity, but now more efficiently applied.

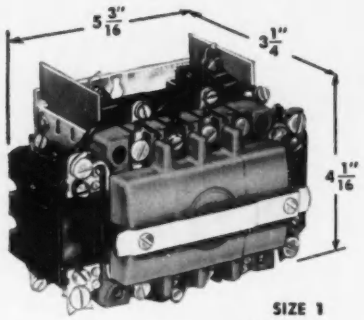
CONTACTS
Double break type.

AUXILIARY ELECTRICAL INTERLOCKS
Available, but could not be added conveniently.

CONTACT ALIGNMENT
No positive guidance, no sure alignment.

WIRING
"Scrambled Wiring" with load terminal on line side and crossing circuits. Difficult to wire and lacking the safety factor of circuit separation.

ARC SUPPRESSION
FAIR but lacking complete separation of arcing chambers. Hood and base of Bakelite — best material available *then*.



SIZE 1
66 CU. IN.

AND IN 1950
THE EXCLUSIVE ARROW-HART "RIGHT ANGLE" DESIGN

JUST 1/2 the SIZE and WEIGHT of any other control on the market.

UNDERVOLTAGE RELEASE
Positive and independent of gravity. Able to operate properly in any position — even upside down.

CONTACTS
Double break type PLUS greater accessibility for easy inspection or replacement.

AUXILIARY ELECTRICAL INTERLOCKS
Easily and conveniently added to provide added utility. Available N. O., N. C. and N. O. — N. C.

CONTACT ALIGNMENT
Contact movement is positively guided through its entire travel. Exact alignment is assured at all times.

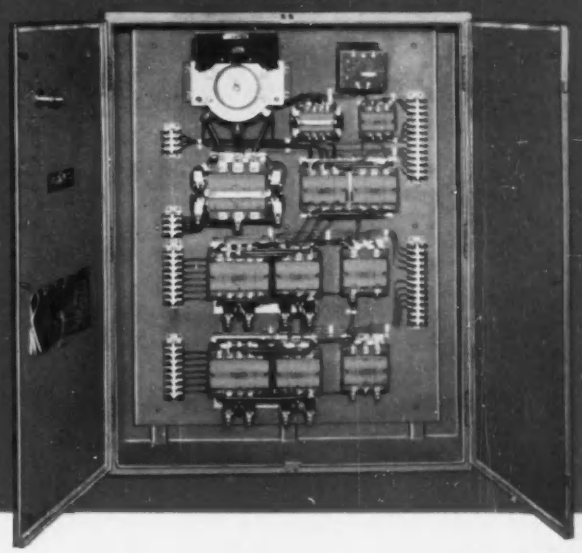
WIRING
In-built STRAIGHT-THRU WIRING without the use of bus-bars. Fast and easy to wire; circuits safely separated.

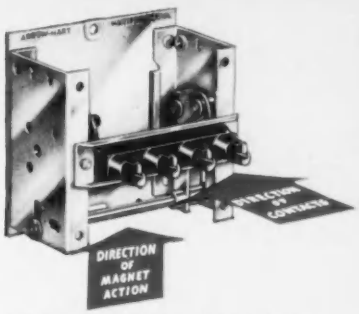
ARC SUPPRESSION
EXCELLENT — Individual arcing chambers completely isolated. Hood and base of alkyd plastic that resists arcing and tracking more than 50% better than next best material.

YOUR ELECTRICALLY OPERATED EQUIPMENT *Demands* MODERN MOTOR CONTROLS

ARROW AH HART

"RIGHT ANGLE" DESIGN *Motor Control Line* IS THE MOST ADVANCED LINE AVAILABLE ANYWHERE



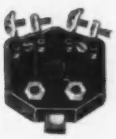


"RA" PRINCIPLE ACCOUNTS FOR SMALL SIZE

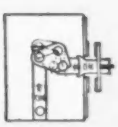
PLUS SUPERIOR PERFORMANCE

POSITIVE RELEASE ACTION IN ANY POSITION

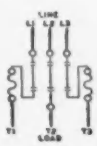
RUGGED CONTACTS



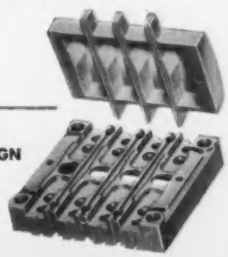
AUXILIARY ELECTRICAL INTERLOCK



GUIDED CONTACT TRAVEL



SIMPLE TO WIRE EASY TO TRACE



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THE "RIGHT ANGLE" OPERATING MECHANISM, an exclusive Arrow-Hart feature, represents the first real advance in motor control design since the introduction of the original solenoid type. This revolutionary new concept makes it possible to build superior performance and added working advantages into a control just ½ the size and weight of any other now on the market. The time-tested bellcrank principle is utilized to produce a mechanical advantage that enables a small, compact magnet to outperform the old fashioned, direct-acting type. Action is transferred from a vertical to a horizontal plane — less weight is wastefully lifted against gravity. Operating efficiency, dependability and service life are greatly increased. Other important refinements such as Straight-Thru Wiring, guided parallel closure of contacts for superior alignment, and easily attached Auxiliary Electrical Interlocks are made possible by the space-saving simplicity of this design.

THERE'S AN ARROW-HART "RIGHT ANGLE" MOTOR CONTROL FOR EVERY APPLICATION

Regular, Reversing and Multi-Speed Starters are available in Sizes 0, 1, 2, 3, 4, 5. — Contactors in Sizes 00, 0, 1, 2, 3, 4, 5. NEMA Type enclosures can be supplied for general service and for use in hazardous and exposed locations.

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INDUSTRIAL CONTROL DIVISION
THE ARROW-HART & HEGEMAN ELECTRIC CO.
103 Hawthorn St., Hartford 6, Conn., U.S.A.

ARROW AH HART

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FOR

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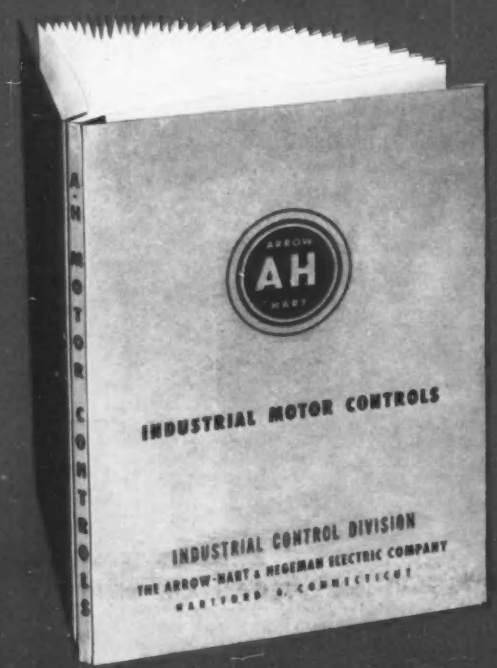
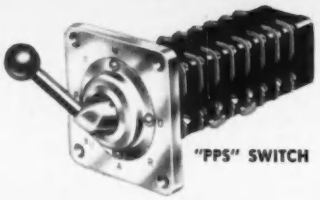
and EVERY OTHER USER OF
INDUSTRIAL MOTOR CONTROLS

Here is the ALL-NEW Arrow-Hart Motor Control Catalog with full information on the entire A-H Line. All of the controls shown below—and many more types—are included. General description and application sections are supplemented by complete engineering data including ratings, weights and dimensions, and wiring diagrams. Additional sections will be issued to cover all new models or modifications as they are made available. A handy ordering sheet and price supplement accompanies the catalog.

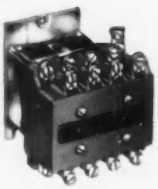
Whatever your requirement, there is an Arrow-Hart motor control complete with auxiliary equipment designed and built to do the job — and do it better. It's easy to find the right unit to do YOUR job in the A-H Catalog. Send for your copy today.

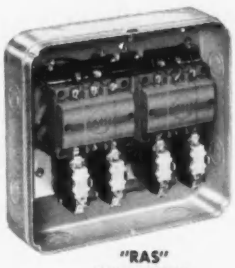



"PPS" SWITCH

PUSH BUTTON CONTROLS

"NF" MANUAL STARTER


"OO" CONTACTOR


"RAS" MULTI-SPEED STARTER

EXPLO-SAFE STARTER

LOAD-LIMIT SWITCH

"RT" MANUAL STARTER

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
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studies, the ortho silicates are considered to be the most promising materials for the formulation of a high temperature hydraulic fluid which will operate from —65 F to low vapor pressures at 400 Fahrenheit.

The Development Engineer

Abstracted from "Developing the Development Engineer" by I. F. Kinnard, *General Electric Review*, March 1953.

THE DEVELOPMENT ENGINEER bridges the gap between the scientific researcher and the design engineer. Results of scientific research are seldom in a form that can be put to immediate practical use, but to the development engineer they may suggest solutions to practical problems. He takes these suggestions and develops them into ideas that can be used by industry, keeping in mind that the ideas must be sound in terms of engineering and economics.

Taking a functional view of the development engineer, his "input" is a new idea or concept, either his own or one that has been assigned to him for commercial development; his "output" is generally an operating sample, usually handmade, accompanied by enough data to prove that the idea is workable.

How Can Management Help?

What are some of the techniques that industrial management can use to further aid the development engineer?

In the first place, developments do not just happen. They must be planned and the proper conditions set up for their generation. Staff your development component with men who have enthusiasm that gives rise to ideas and possibilities—men of resourcefulness, ingenuity, and imagination—and give them a proper place to work.

A proper environment for creativity is important. This involves two areas: assignment and physical facilities. Wherever possible, give the development engineer no other responsibility than the development of new products. Experience has shown that he will work best in a laboratory atmosphere, away from the immediate problems of daily production. Do this not because the development engineer is a superman, above soiling his hands with manufacturing problems, but be-

CHEMICALS ACP PROCESSES

phosphate coating chemicals

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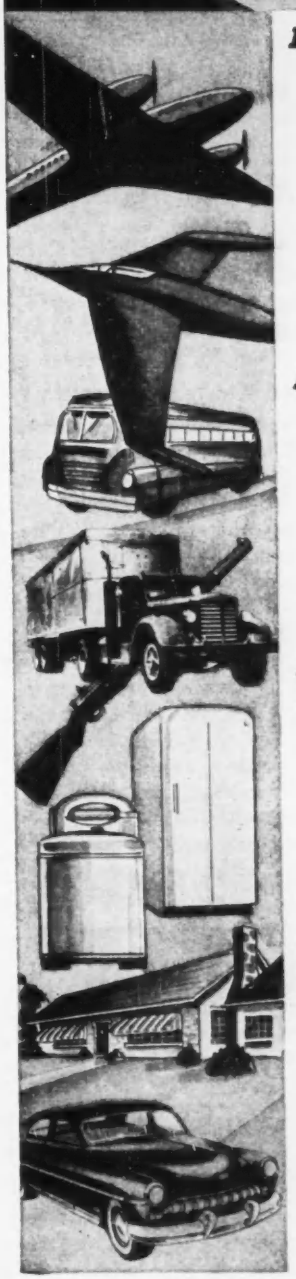

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"GRANODINE"® forms a zinc-iron phosphate-coating bond on sheet metal products—automobile bodies and fenders, refrigerator cabinets, etc.—for a durable, lustrous paint finish.

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"PERMADINE",® a zinc phosphate coating chemical, forms on steel an oil-adsorptive coating which bonds rust-inhibiting oils such as "Granoleum."

"THERMOIL-GRANODINE"® a manganese-iron phosphate coating chemical, forms on steel a dense crystalline coating which, when oiled or painted, inhibits corrosion.

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The oiled "THERMOIL-GRANODINE" coating on pistons, piston rings, cranks, camshafts and other rubbing parts, allows safe break-in operation, eliminates metal-to-metal contact, maintains lubrication and reduces the danger of scuffing, scoring, galling, welding and tearing.

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"GRANODRAW"® forms on pickled surfaces a tightly-bound adherent, zinc-iron phosphate coating which facilitates the cold mechanical deformation of steel, improves drawing, and lengthens die life.

Send for descriptive folders and Government specifications chart on the above chemicals. Write or call for more information on these products, and advice on your own metal-working problem.

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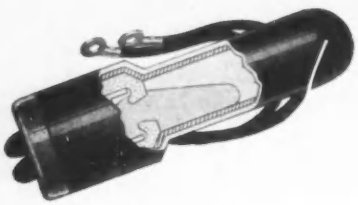

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cause any good engineer is better able to do creative work when free of distracting influences.

By working in a laboratory he will derive great stimulation from contact with other development engineers and scientists engaged in the attack on different but related problems.

Another factor to watch is this: Don't attempt too rigid a distinction between development engineering and design engineering. The difference is one of degree and emphasis rather than kind. The design engineer takes the developments provided by the development engineer and adapts them for manufacture. His "input" is handmade working sample; his "output" is a highly refined design suitable for manufacture.

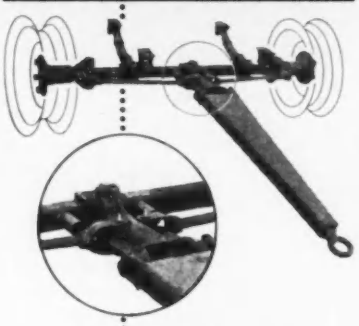
What Does Management Expect?

The development engineer should constantly maintain interest in attaining his goal. He minimizes diversions and isn't sidetracked by subsidiary investigations. He analyzes his data for accuracy and for the effect of environmental influences. He knows the patent situation with regard to his project and recognizes patentable contributions when he makes them.

He doesn't waste time and money in the support of a lost cause but knows that mistaken approaches should be recognized early in the game—not in the production phase. He takes schedules and commitments seriously and remembers that a profitable item starts earning only after it is in production.

A PARTIAL SOLUTION to the technical manpower problem is offered by two members of the team of U. S. Scientific Research Consultants which the Mutual Security Agency sent to Italy last year to study the development of industrial research in that country. They say that U. S. industry might consider the establisment of "branch" research establishments abroad, specifically Italy. The team points out that (1) Italy trains high caliber technical manpower, of which it produces more than it can use, (2) Italian research institutes can do applied research at an overall cost about 30 pc below U. S., and (3) Italian research establishments are equipped and organized to handle an increased program

UNITED CARAVAN AXLES



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OUR READERS SAY

Suggests Feet Per Minute In Place of Rpm

To the Editor:

I believe that there is a mistake in Table I in the article "Selecting the Right Plain Bearing Lubricant," which appeared on page 134 in the March 1953 issue of *Product Engineering*.

In Table I in the speed column, the unit given is rpm. Since the shaft diameter is not assumed, rpm should not be used to indicate speed. The rpm must be converted to inches per minute or feet per minute.

Will you kindly teach me the relation between the unit of viscosity SSU of the Table I and the Saybolt Universal Seconds or Kinematic Viscosity centistokes.

—YOSHIRO EGI
Aboshiku, Himejishi, Japan

Author's Reply—Here in the United States it has been our habit in recent years to refer to speed of shafts incorporating plain bearings in terms of revolutions per minute rather than feet per minute. This may or may not be a good practice. I can certainly see Mr. Egi's point in recommending either inches per minute or feet per minute. He evidently bases his theory on the fact that perhaps one should use different viscosities of oil for small shafts versus large shafts operating at the same speed, and I agree that this is good practice. However, in the United States there has been more or less of a standardization in the sizes of shafts operating at definite speeds. In other words, it is rare that one would find a 10 in. shaft operating at 10,000 rpm. Generally speaking, with few exceptions, the higher speeds are limited to the smaller shafts. This gives us an opportunity then to refer to the viscosity limits within certain speeds in revolutions per minute.

The table on Page 134 is fundamentally correct. It may be that Mr. Egi might think that the viscosities are a bit on the light side; however, with the advent of better materials and better finishes, there has been more

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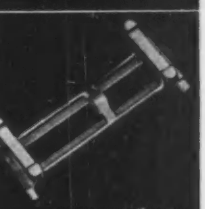
NO. 40 *High Strength* ALUMINUM *"Tenzalloy"*	Attains high strength through natural aging. Free from internal stress and skin hardness. Ideal for machining.	
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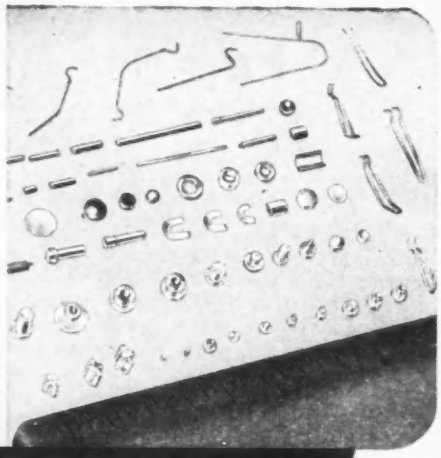

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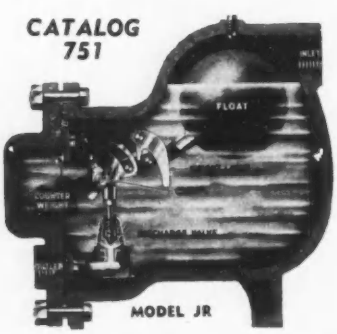

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TRAPS · VALVES · FLOATS

and more tendency to lighten up the viscosity in order to cut down the coefficient of fluid friction. We must not lose sight of the fact that this is a *guide* and cannot be expected to fit every single case. It is merely a guide to aid designers and users to select an oil which will function satisfactorily under the conditions described.

Below is the information requested by Mr. Egi regarding the relationship between Saybolt Universal Seconds and Kinematic Viscosity.

Values For Converting Saybolt Universal Viscosity to Kinematic Viscosity

Kinematic Viscosity, cs	Equivalent SUS at 100 F.
2	32.6
3	36.0
4	39.1
5	42.3
6	45.5
7	48.7
8	52.0
9	55.4
10	55.8
15	77.2
20	97.5
25	118.9
30	140.9
40	185.7
50	231.4
60	277.4
70	323.4
Over 70	Saybolt sec = cs × 4.620

B. M. DUNHAM,
Technical Consultant,
Sun Oil Co.

Comments On Memory Devices

To the Editor:

Your article, "Making Machines Remember" in the April 1953 issue of *Product Engineering* has been of great interest to our group, some of which have been engaged in ultrasonic research since 1943.

This timely article presented much information on types of memory devices which we do not make, and has therefore been of great value to us and no doubt to many others who may or may not have an active interest in memory units.

Besides expressing our appreciation, we do feel it worthwhile to mention a few facts about ultrasonic delay lines which were at variance with the present state of affairs, and which we real-

ize were due to the difficulties in covering briefly all factors of the problem.

At present, the mercury delay line is obsolete because of its high insertion loss, high temperature coefficient, and high cost of manufacture and maintenance as well as poor resistance to shock. The use of solid media is now almost universal, but glasses rather than magnesium alloys are being chosen. The glasses are much more reproducible and are available with small or zero temperature coefficients. Furthermore, they have somewhat wider bandwidths and allow closer packing of the pulses. The access time for delay lines is determined by the length of the delay line and can be made to fit any desired range between one microsecond and several thousand. The value of 200 microseconds shown in your Table I is, however, a suitable value for certain computers.

—DAVID L. ARENBERG
Arenberg Ultrasonic Laboratory

Has Difficulty With Kerosene Lubricated Machines

To the Editor:

I have been reading *Product Engineering* for about 4 years, but have never seen an article on kerosene spindles.

Kerosene is not much of a lubricant, but we have some spindles in our shop that are lubricated by kerosene, and we have trouble with them.

If there has been anything written on the subject during the time that I did not read *Product Engineering,* I would appreciate receiving tear sheets of the article. Also, if there has been a book written on the subject, please give me the publisher's name.

—G. J. NEWPORT

Ed—Sorry, *Product Engineering* has never carried an article on kerosene lubricated spindles. We suggest that you contact the manufacturer of your machine, or some of the oil companies for possible substitutions of lubricants.

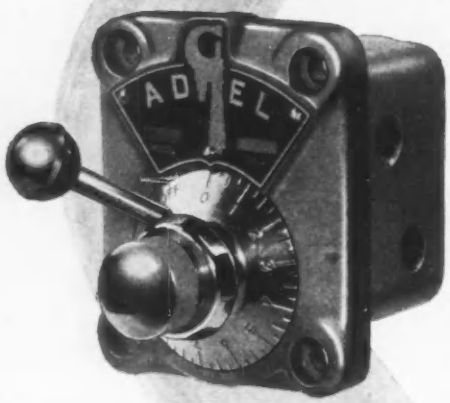
Using PE Article In Patent Law Course

To the Editor:

If they are available, I would appreciate your sending me 40 reprints of the article, "The New Patent Law of

THE NEW ADEL

FLOW CONTROL VALVE FOR VERSATILITY



Adjustable from completely shut off position to 25 G.P.M. maximum flow. Will maintain constant fluid flow and constant machine feed over a wide range of pressures and feed resistances.

The diagrams show but two of innumerable circuits and systems where this versatile and better valve can be used to advantage.

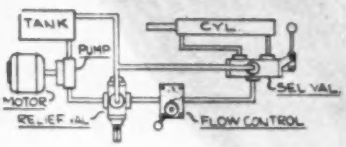


Diagram illustrates typical circuit showing control of cylinder.

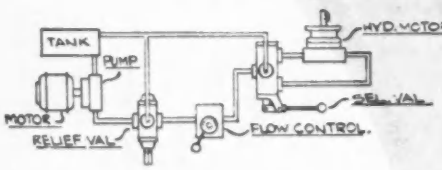


Diagram illustrates typical circuit showing control of hydraulic motor.
8 model variations are available—¾ in. Pipe Size—1, 2, 4 & 6 G.P.M. Flow Max.
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1953," by H. A. Toulmin, Jr., which appeared in your April 1953 issue. I intend to distribute these copies to my classmates (and instructor) in the current course in Patent Law at the Graduate School of Stevens Institute of Technology, Hoboken, New Jersey. The information contained in this article should be of tremendous interest to everyone in the class.

At the head of the above mentioned article, you make reference to a previous article by the same author, "Patents and the Engineer," which appeared in two parts in the June and July, 1948, issue. I would like two reprints of that article also, if they are available. —PRESTON D. LIEBIG
Aircraft Gas Turbine Div.
General Electric Co.

Ed—We are sending you tear sheets of the above mentioned articles and are gratified to learn that you consider them worthy of use in your course on Patent Law.

That April Editorial

We have had so many requests for extra copies of the editorial, "A Graduate Can Measure A Bottle", that we have found it necessary to reprint it. Extra copies will be sent gratis to any readers wanting them.

Low Frequency Induction Heating for Alcoa

ANOTHER PIECE was fitted into the Air Force's big press program by Alcoa's report that it succeeded in bringing a 7,700 lb aluminum ingot to the working temperature of 750 F in 50 minutes, compared to the 12 hours normally required.

Using ordinary household current, the new induction heating method is said to open up increased flexibility of operation for the large forging and extrusion equipment now under construction.

Cost-wise, the low frequency heating technique is stated to compare favorably with installation and operating figures for conventional equipment. But the important saving will lie in speeding up producton.

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Nuclear System Generates Electricity

THE CONCEPT OF ATOMIC POWER PLANTS as the generating stations of the future was bolstered by the announcement of AEC's Oak Ridge National Laboratory that an unique reactor system had successfully generated 150 kilowatts of electricity. While nuclear generating plants are conceded to be at least ten years off, this test run earmarked the first reactor to operate at a temperature and power high enough to produce steam to run a commercial turbo-generator.

An experimental homogenous reactor formed the basis for the test run. One solution served as fuel, moderator and coolant. Heat generated by the nuclear reaction of the uranium in the solution was removed by pumping the hot radioactive liquid through a small boiler which in turn produced the necessary steam to operate the turbine.

Project scientists pointed out that while the reactor ran as hoped, the reactor was not designed to produce economic electric power. Many problems still remain to be solved before electricity generated can compete with low cost conventional power plants. However, optimism is running high because the test proved a principle—that the use of homogenous liquid fuel, reactor systems is feasible for atomic power plants of the future.

This electrical experiment took over 2½ years and cost about four million dollars. Actually, the test ran at full power for only a short period of time. Engineers still don't know what will happen under continuous operation, and at higher temperatures and power. Meanwhile, research efforts are being intensified to learn more about corrosive action of nuclear solutions, heat transfer problems, and strength of promising alloys at high temperatures. What everyone agrees is the biggest stumbling block is lack of experience. However, many research labs feel that this program should not be pushed as was necessary with the atomic bomb. They claim that an orderly process will pay off in better results and at less cost.

Another concept that industry engineers are keeping in back of their minds is the extreme cheapness of uranium for this type of work. They

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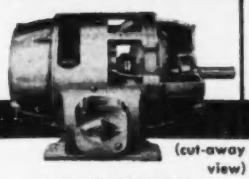

(cut-away view)

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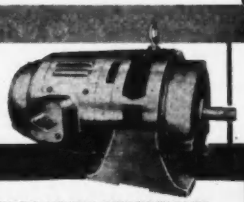

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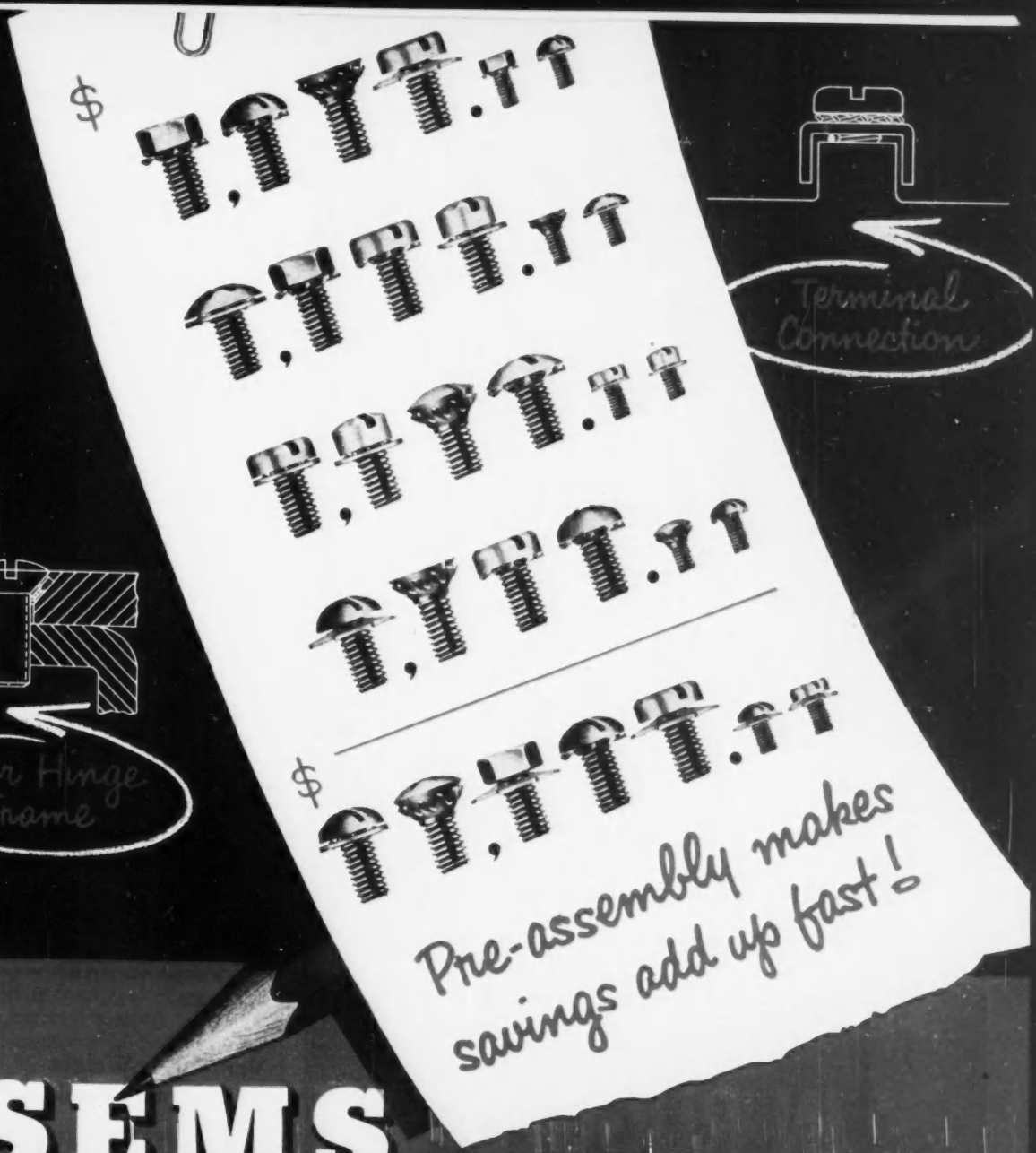

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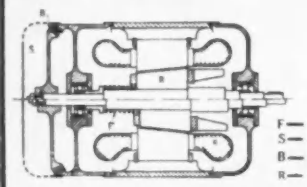

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predict that the life of the uranium pile will make the cost of the fuel negligible for steam generation. With this economic fact to back them up, some power plant engineers contend that an entirely new idea of power plant operating temperatures and pressures will result. A cheap fuel will permit designers to work within lower limits, which in turn will mean less trouble with corrosion and strength.

Physical Properties Checked Optically

A MAJOR ADVANCE in industry's methods of measuring alloying constituents in aluminum, brass, stainless steel, magnesium and low alloy steels is speeding quality testing time from four hours to five minutes, reports Fairchild's Aircraft Division. Replacing costly and time-consuming "wet" methods of chemical analysis, the new direct-reading spectrometer instantaneously reads the percentage of each element in the metal.

Principal value lies in use as stock control device. The unit verifies the chemical analysis affidavits submitted with shipments of raw materials speeding the acceptance and stocking of metals. Rods, plates, billets, sheets, extrusions, tubes, bars and forgings are checked with the spectrometer. Object is to make sure hardness, corrosion resistance and tensile strength properties do not dip below specification limits.

New Light Weight High Luster Metal

Lurium, a trade name given to 99.99 percent aluminum, is being shipped from West Germany as the answer to demands for light weight parts that do not tarnish or loose their luster, according to Fromson Orban, New York importers.

Weighing one-third that of brass or copper, the new metal will be available in standard raw mill forms and from soft to hard tempers. But because of special finishing methods required, Fromson will have metal processed by an American plant before being shipped to user.

Called a work hardening alloy, Lurium is said to be easy to fabricate, and may be anodized and dyed in any color to match other non-ferrous metals. Cost is claimed to be low.

NEW BOOKS

ASTM Standards on Light Metals and Alloys

205 pp, 6 x 9 in. Published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $3.

This special compilation of ASTM Standards on Light Metals and Alloys, gives the numerous specifications and tests issued through March 1953. In addition to the recommended codification there are groups of specifications for aluminum and aluminum-base ingots, castings, bars, rods, wire and shapes, forgings, pipe and tubes, sheet and plate. Specifications for wrought products for electrical purposes include those for bars, various types of electrical conductors, wire, etc.; also a test for resistivity. There are two specifications for filler metal-electrodes and brazing materials and the recommended practice for electroplating is given.

In the field of magnesium and magnesium-base alloys there are standard requirements also for ingots, castings, bars, rods, and shapes, forgings, sheet and tubes.

There are seven general test methods covering these light alloys, which include dielectric strength, weight of coating, measuring of thickness, tension testing, and sampling.

Analysis of Aluminum Alloys

G. H. OSBORNE *and* W. STORES. *144 pp., 6 x 9 in. Published by The Chemical Publishing Co., Inc., 212 Fifth Ave., New York* 10, *N. Y.* $3.50.

This is a survey of analytical methods for determining the chemical composition of aluminum alloys. Many of these are new, others are modified versions of known methods, and a few are established standards. Methods range from those requiring modern physiochemical instruments, such as a polarograph and photometer, to those which may be carried out with the normal equipment available in the general chemical laboratory. Every method has been thoroughly tested by

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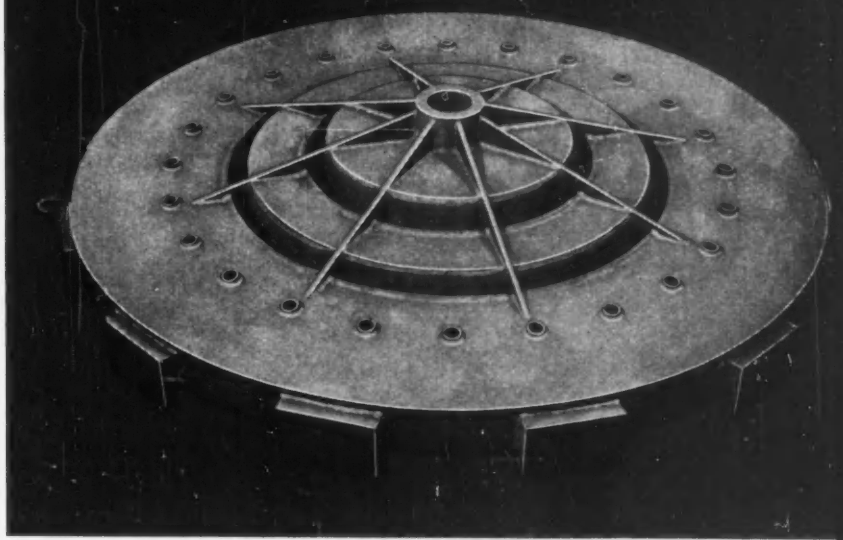

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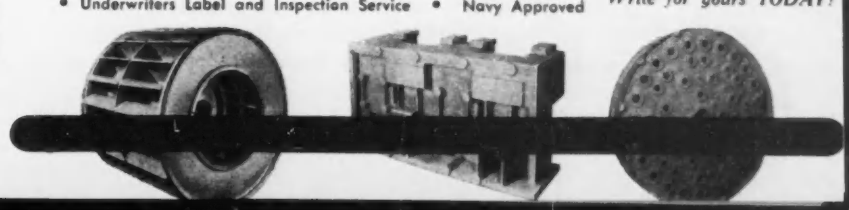

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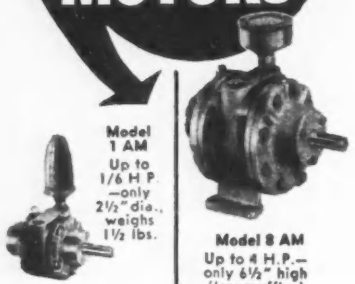

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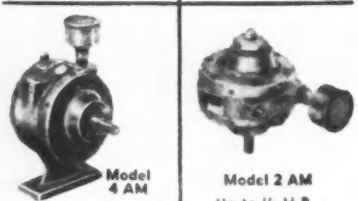

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extensive application in industrial laboratories. Details of procedure have been supplemented, by theory.

The book discusses gravimetric, volumetric, electrolytic, photometric and polarographic methods for the determination of the most common elements, such as copper, magnesium, silicon, iron, manganese, nickel, zinc, tin, antimony, and chromium. It includes the principles involved, reagents and apparatus required, and the procedure to be used.

Methods for the determination of less common elements such as berryllium, bismuth, calcium, silver, and sodium are also prescribed.

Electric Control Systems

RICHARD W. JONES, *Professor of Electrical Engineering, Northwestern Technological Institute. 511 pages, 6 x 9 in. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. $7.75.*

The subject is covered on a level which is suitable for senior students who have had courses in a-c and d-c machinery, ordinary differential equations and basic electronics. As in the first two editions, this new text organizes its material on a functional basis which aids the student in the process of coordinating his previous work on circuits, electronics and machinery. The material is sufficient for a one-semester course having three lectures and one laboratory session each week. The questions and problems at the end of each chapter are of varying degrees of difficulty and many bring out additional concepts not discussed in the text. Although the bibliographies are far from exhaustive, most of the significant literature can be located through the references given.

The material covered is as follows: dynamics of the motor and load, d-c motor characteristics, a-c motor characteristics, electromagnetic contact-making devices, gaseous electronic switching devices, electronic switching circuits, power amplifiers, control circuit fundamentals, basic motor control circuits, motor acceleration, speed control-rheostatic and switching methods, speed control with auxiliary power converters, motor braking, feedback control systems and motor protection.

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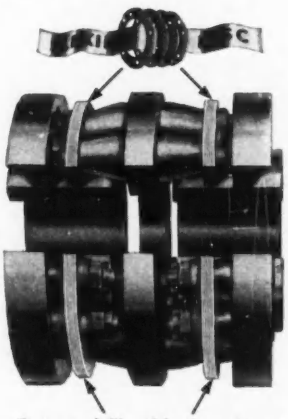

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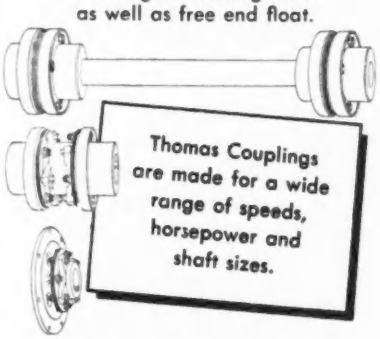

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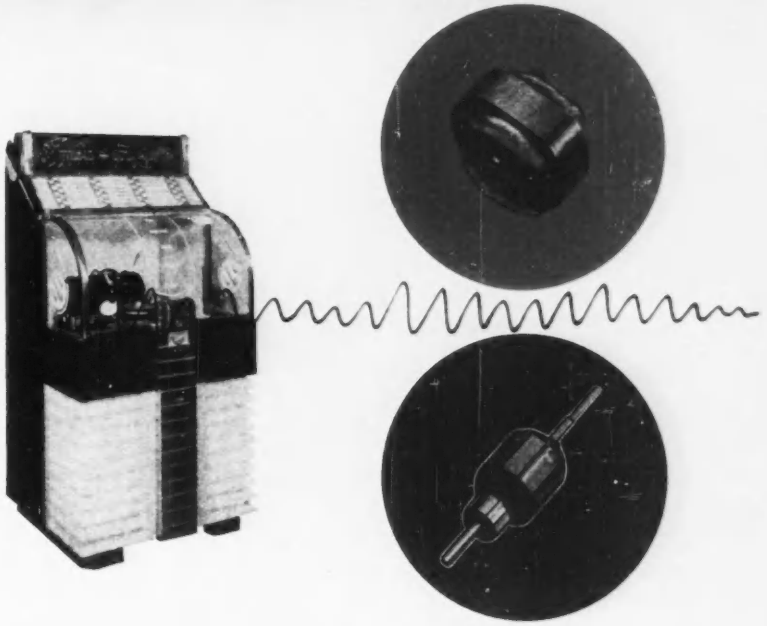
throughout and helps the student to concentrate on basic principles. Thus, both analysis and graphical methods are used to develop basic ideas. Relay or binary switching circuits are covered with Boolean algebra being introduced for this purpose. This topic is becoming increasingly important but has been notably lacking in undergraduate curricula. Most of the book is concerned with control systems having no feedback, although the fundamental concepts of feedback and the operation of a few simple feedback controllers is introduced in one of the later charters. This supplies the background for more advanced work in feedback control systems.

Calculus and Analytic Geometry

GEORGE B. THOMAS, JR., *Associate Professor of Mathematics, Massachusetts Institute of Technology.* 731 *pp.* 6 x 9 *in. Published by Addison-Wesley Publishing Co., Inc., Cambridge* 32, *Mass.* $8.50.

This book is probably best described by the author's statements ". . . that of the two branches of calculus, the integral calculus is the richer, both mathematically and in applicability to the physical sciences and engineering. It is therefore the primary objective of this book to introduce the student to the fundamental concept of integral as limit of a sum at as early stage as seems pedagogically practicable."

His work is divided as follows: Chapter 1—The Rate of Change of a Function; Chapter 2—Derivatives of Algebraic Functions; Chapter 3—Applications (Significance of first and second derivatives, maxima and minima, curve plotting, Rolls theorem, etc.); Chapter 4—Integration (indefinite and definite integrals, length, area, volume, average value of a function, etc.); Chapter 5—Applications of Integration to Physics; Chapter 6—Plane Analytic Geometry; Chapter 7—Polar Coordinates; Chapter 8—Transcendental Functions; Chapter 9—Hyperbolic Functions; Chapter 10—Methods of Integration (Basic formulas, powers of trigonometric functions, integration by method of partial fractions, integration by parts, substitutions, etc.); Chapter 11—Vectors and Parametric Equations (Parametric



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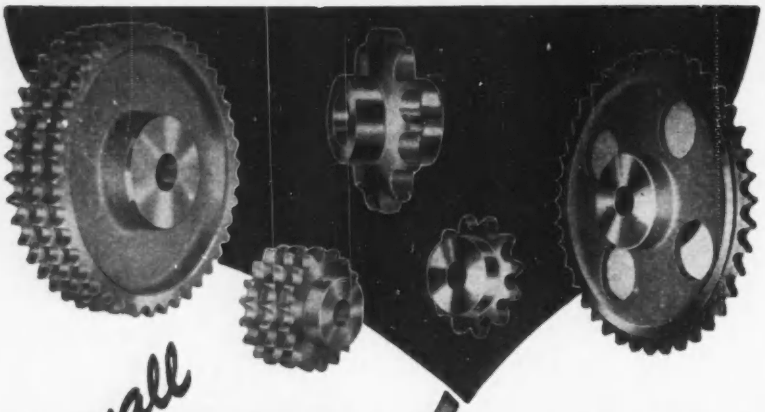

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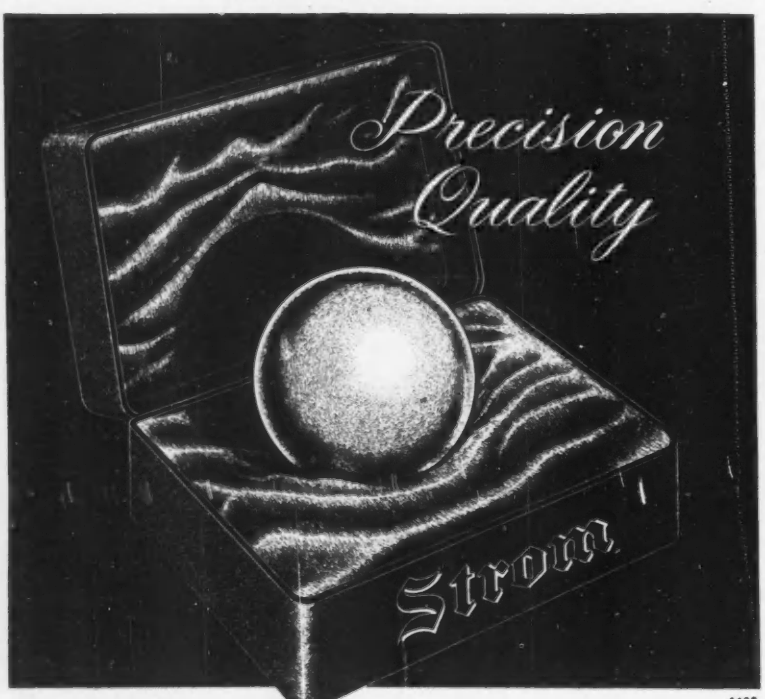

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Higher Transcendental Functions, Volume I

Edited by A. ERDELYI, *Prof. of Mathematics, California Institute of Technology.* 302 *pp.*, 6 x 9 *in. Published by the McGraw-Hill Book Co.,* 330 *W.* 42*nd St., New York* 36, *N. Y.* $6.50.

This is the first of a four volume set of reference of advanced mathematical tables which will be of great usefulness in fields of engineering, physics, and mathematics. The books are being published in association with the California Institute of Technology, the compilation proceeding under the auspices of the Office of Naval Research. The work will provide a comprehensive account of practically all the higher transcendental, or "special" functions which have been found most useful in pure and applied mathematics.

This first volume contains material on the Gamma function and related functions, Legendre functions, the hypergeometric function, confluent hypergeometric functions, and generalized hypergeometric functions.

This is the first work of such scope and scale, providing all the information commonly needed on special functions. The presentation varies in relation to the nature and application of the functions, being textbook-like in detailed accounts of some functions, while briefly descriptive of the properties of others. Copious references

to the literature in the field are offered. A strong feature is the inclusion of tables of formulas relating to the functions treated.

Some of the results included in the book are new and either have not been published previously, or else have appeared only in recent specialized periodicals. Many special topics, heretofore discussed in scattered and inaccessible research papers, have been incorporated. These include MacRobert's E-function, Meijer G-function, and hypergeometric functions of several variables. In short, this is a reference work aimed specifically at the practical mathematician.

Introductory Engineering Materials

IRVING H. COWDREY, *Assoc. Prof. of Testing Materials, Mass. Inst. of Tech., and* EDWARD L. BARTHOLOMEW, JR., *Assoc. Prof. of Mech. Eng., Univ. of Conn.* 424 *pp*, 5½ x 8¼ *in. Published by McGraw-Hill Book Co.*, 330 *W. 42nd St., New York* 36, *N. Y.* $6.

Emphasizing the logical development of basic concepts the authors have intended this book primarily for students in the Technical Institute and Junior College level. It may also serve for basic study at the college level. It is not intended, however, as a reference book for the design engineer, rather it is intended to give a secure foundation for understanding, interpreting, and applying data which abound in the many handbooks available today.

This presentation was chosen to give the student an uncluttered understanding and familiarity with the methods, materials, and cause and effect which purely factual material does not accomplish. Since these basic principles remain unchanged beneath the flux of future development in the field or the introduction of new materials, this broad treatment offers a universally applicable method of thinking about materials, what they are, and the relationships between structures, treatments, and properties.

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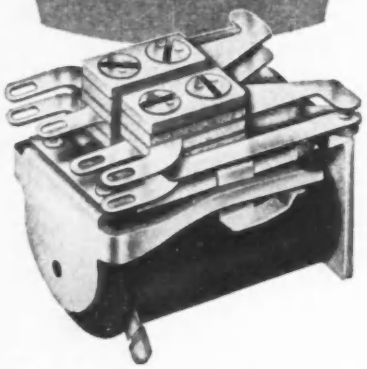

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derstanding of the physical picture. This is furthered by an emphasis on correlation between structure and properties.

In the metallic section, constant use is made of photo micrographs rather than equilibrium diagrams to illustrate what happens by actually showing how internal structures result from certain composition and processes, and in turn determine the mass characteristics. Wherever possible, graphs replace tabulations as an aid to visual understanding.

Recent advances included are continuous casting, carbo-nitriding, ductile cast iron, boron-treated steels, aluminum alloy and sleeve bearing. Testing methods are more fully developed than average.

Principles of Alternating-Current Machinery

RALPH R. LAWRENCE, *Prof. Emeritus of Electrical Machinery, Mass. Inst. of Tech. Revised by* HENRY E. RICHARDS, *Prof. of Electrical Engineering, Northwestern Univ.* 623 *pp*, 6 x 9 *in. Published by the McGraw-Hill Book Co.*, 330 *W. 42nd St., New York* 36, *N. Y.* $7.50.

This fourth edition, is a major revision bringing the subject matter up to date to include new advances in the field, while retaining the same form, scope, and general treatment. Designed, as before, for a senior course, it provides a comprehensive analysis of the operation and characterisitcs of transformers, synchronous generators, synchronous motors, polyphase induction motors, series motors, and repulsion motors. Other subjects considered in less detail are the induction generator, synchronous converter, and mercury-arc rectifier.

The treatment is strongly analytical, designed to give the student a thorough understanding of the way each machine works and the reasons for any special characteristics. The text excels in the completeness of its analysis of steady-state operating conditions for all major types of alternating current machines. It offers sound reasons for current practice rather than merely stating present day usages. True understanding is facilitated by actually deriving formulas and working equations from basic theory instead of ac-

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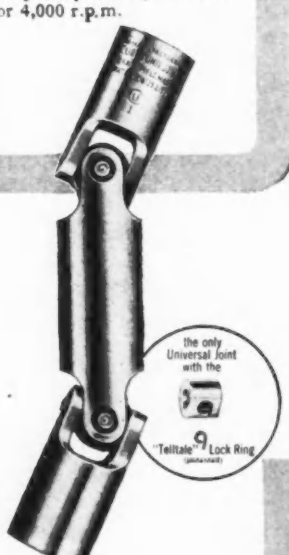

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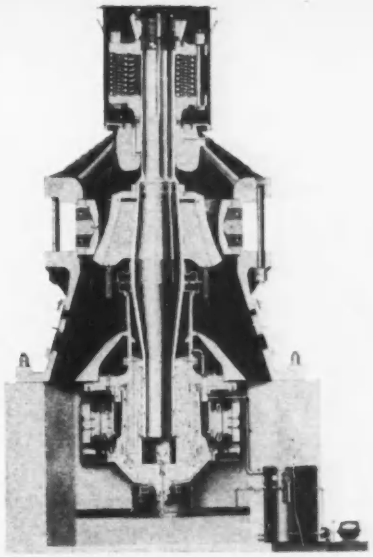

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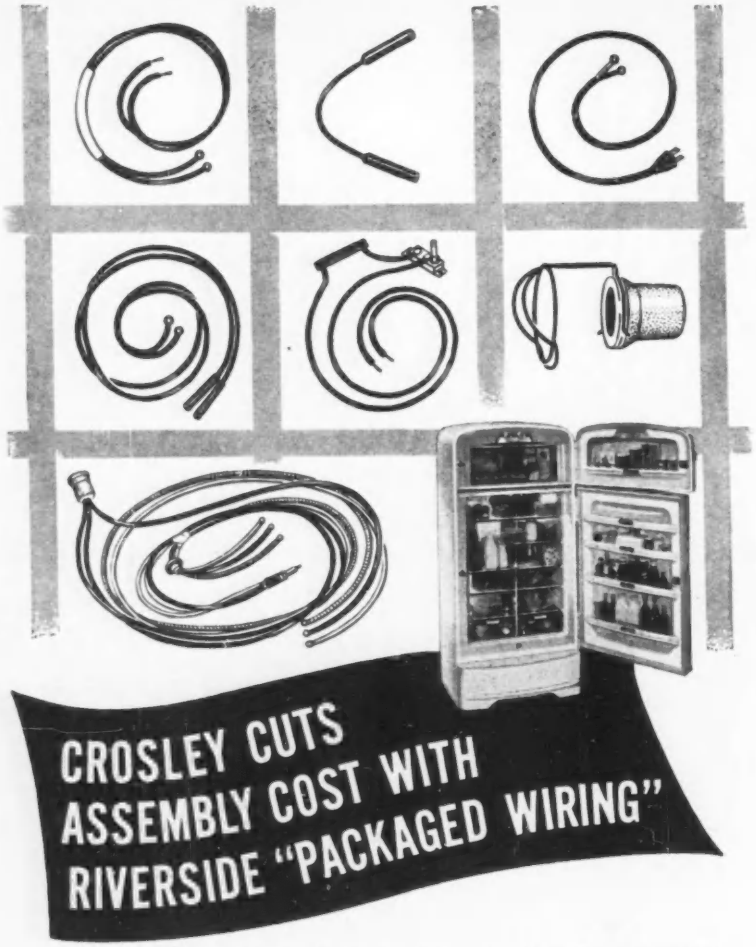

Crosley's "Shelvador" refrigerator line, twice awarded the Fashion Academy Gold Medal for advanced styling, adds to its laurels with this beautiful "Twin Automatic." A medal for smart production engineering might well be awarded too, for Crosley incorporates the use of efficiently designed Riverside electrical components that can be installed quickly, easily, and inexpensively!

We deliver these sub-assemblies completely fabricated, ready for installation. Thus, along with *assembly savings*, Crosley avoids upkeep of the specialized facilities required to *produce* such electrical components, a considerable saving in itself.

The design and production of wiring assemblies is a highly specialized business . . . and a Riverside specialty! Our Engineering Department is devoted solely to solving wiring problems . . . while specialized production equipment and skilled personnel translate its recommendations into efficient, economical "packaged wiring." It will pay *you* to send prints or details of *your* product wiring problem for design suggestions and a firm quotation. There is no obligation.

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Riverside Manufacturing
AND ELECTRICAL SUPPLY COMPANY

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WIRING HARNESSES AND ASSEMBLIES • CORD SETS • HEATER AND EXTENSION CORDS • ELECTRICAL SWITCHES • RELAYS • MOLDED RUBBER PRODUCTS

cepting them only on faith. The use of mathematics and vector diagrams conveys a great amount of information in a small space and encourages an analytical approach to the subject. Many changes have been made for clarity, logic, and more convenient presentation and coverage. Transformers are now treated first, followed by other types of machines, since this treatment is more in accord with present day practices. Cgs units are replaced by mks or English practical units to conform to modern usage. Specific conventions are offered for determining positive directions of flux, currents, and voltage. An amplification of autotransformers is offered. In treating synchronous reactance methods an extensive discussion of the "American Standards Association" method, is given. Material on the capacitor motor has been expanded in light of its growing importance. An important change is the total rewriting of the chapter on methods of calculating performance of polyphase induction motors for conformance with contemporary practice. Finally, a great deal of important new material has been added to the text.

Simplified Drafting Practice

WILLIAM L. HEALY *and* ARTHUR H. RAW, *General Electric Co.* 8½ x 11 *in.*, 156 *pp. Published by John Wiley and Sons, Inc., 440 Fourth Ave., New York, N. Y.* $5.

This book marks the first major change in industrial drafting practices in years. It teaches new methods that are vitally necessary if the draftsman is to keep in step with the trend of modern industrial progress. The time element is dictating that drafting, or the key function between invention and production, produce drawings faster, with less effort—drawings that are easily read and interpreted.

The early chapters of this book devote themselves to the three principles that can immediately be used to save time and increase productivity. These are: (1) simplification; (2) eliminating unnecessary work; and (3) freehand drawing. The first two simply means leaving off drawings and layouts those things which add nothing to their accuracy, completeness or clarity. For example, internal threads

need not be shown but merely noted. This follows the ASA approach of simplified delineation. Going one step further, if the circle is eliminated from the end view, cross-hatching from a section and dotted lines showing the thread depth additional time can be saved. Additional time and labor savings can be realized by using standard symbols and center lines for piping, valves, tees, and other similar parts.

Freehand drawing, when used judiciously, is both practical and economical. All factors being equal, actual drawing time for the average draftsman can be reduced 20 to 30 percent. Simple contours and detail parts are most suited but even large and complex drawings lend themselves to freehand and instrument use. On assembly drawings, for instance, small radii, holes, and hardware can be effectively drawn freehand.

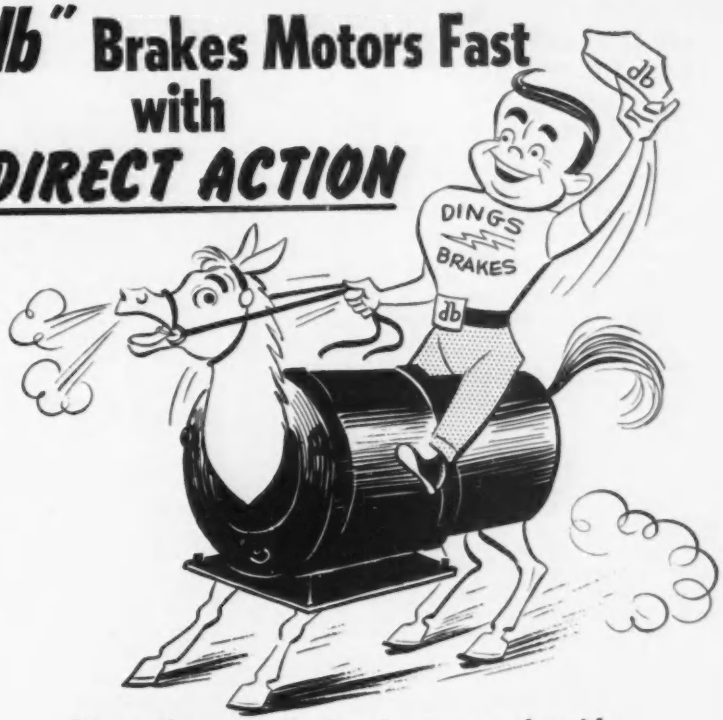
Other chapters cover the use of symbols and mechanical aids. Templates, for circles, arrowheads, surface finish marks, electronic diagramatic elements, nuts, bolts, and other symbols are available from drafting supply houses and manufacturing companys. The use of a varitypewriter can save hours of expensive hand lettering and a neater, more easily read drawing is produced. These machines are made to take any size drawing and interchangeable type allows a wide selection of type face, style and size.

Progressive dimensioning, another chapter, requires less space on a drawing for dimensions and the drawing is clarified and time is saved. This resembles the well-known method of dimensioning a chart or graph, in that a datum line is selected and all dimensions originate from this line. This allows a large portion of the measurements to be made from a given datum line by one setting of the measuring device. This is especially useful and time saving when machines equipped with built-in measuring or gaging devices are used.

Other chapters cover tolerances, use of instructions, drawing forms and related routines, and reproduction processes.

The book is well illustrated with simple and complex examples of the points discussed and the authors are well qualified to undertake such an assignment.

"db" Brakes Motors Fast with DIRECT ACTION



Dings Magnetic Brakes have no solenoids, Mechanical linkages to wear or adjust . . .

SET OR RELEASE with Dings Brakes is virtually instantaneous—movement of the braking assembly is measured in thousandths of an inch. Direct spring action sets the brakes. Magnetic pull releases them.

Speed isn't the only advantage of Dings direct control design. Wearing parts have been reduced in number. Less maintenance is required and space is saved.

LOOK AT THESE OTHER DINGS BRAKES FEATURES

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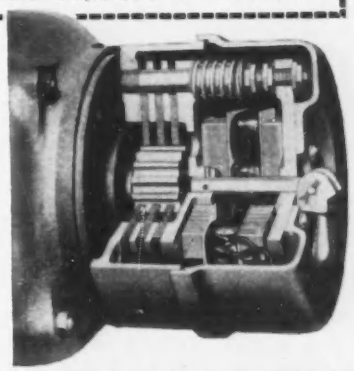
- **High Thermal Ratings—longer life with more stops per minute.**
- **Manual Release—handy lever serves as wear indicator, resets itself.**
- **Easy Adjustment for Torque and Wear—just a twist of a wrench on the adjusting nuts.**



Send for Catalog on Integral and Fractional Horsepower brakes.

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Pressure controller cuts in steam pump when electric power fails

The diagram at right shows how the Honeywell Pressure Controller is applied in a typical installation, for automatically changing over from electric to steam operation on a pumping unit. The two pumps are connected to the same suction and discharge lines, with check valves in each outlet pipe.

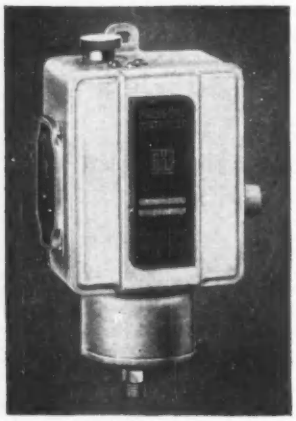
Under ordinary circumstances, the electric-powered pump carries the whole load, while the steam pump stands idle. Connected to the outlet line of the electric pump is a Honeywell P097A Pressure Controller. This controller regulates air pressure to a diaphragm-motor valve in the steam supply line for the standby pump. As long as pressure stays above a preset minimum, the steam valve remains closed.

If power should fail, pressure begins to drop. The instant it reaches the controller's setting—a little above the normal suction pressure—the controller opens the diaphragm valve. The steam pump takes over the pumping job so quickly that there's no appreciable interruption of flow.

Then, when electric power is restored, the controller automatically shuts down the steam pump as soon as pressure rises on the discharge side of the electric pump.

Note that the check valve prevents the pressure controller from being affected by the output of the steam-driven pump. Proper adjustment of the control setting eliminates false action due to temporary drops in pressure.

The more than 7000 Honeywell control devices offer unlimited uses for regulating temperature, pressure, liquid level, vacuum and humidity. All are built for the utmost in dependability . . . and they're backed by Honeywell's nationwide service organization.



Honeywell P097A Pressure Controller

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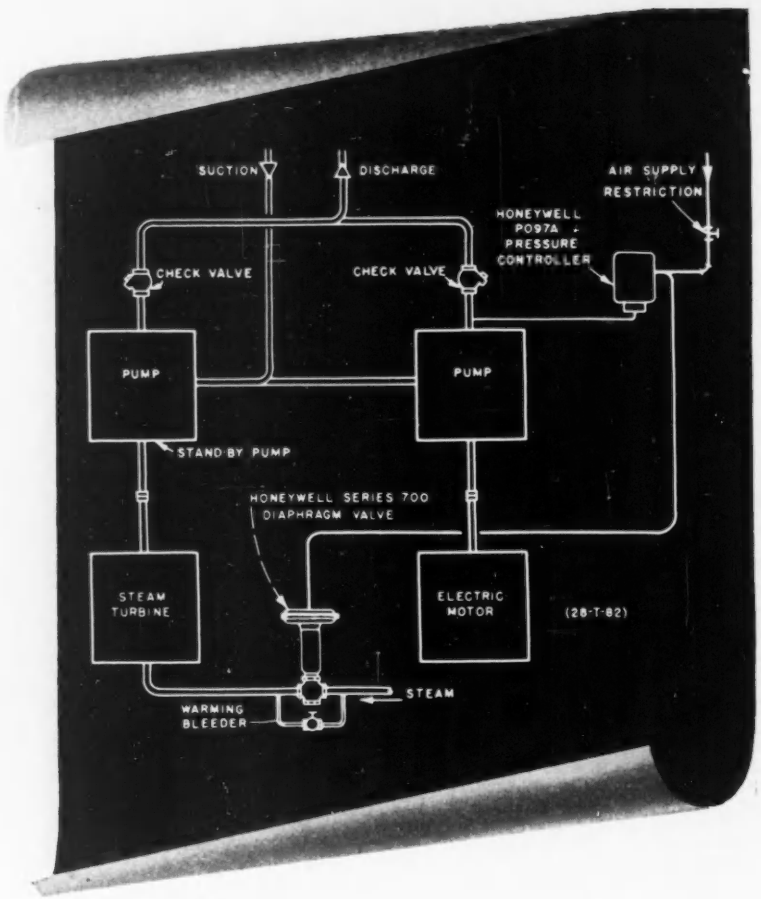
You'll find a wealth of ideas on how to use automatic controls in *Industrial Control News*. If you're not already receiving this informative magazine, just send your name, company, title and address to MINNEAPOLIS HONEYWELL REGULATOR CO., *Industrial Division*, Station 213, 4459 Wayne Ave., Philadelphia 44, Pa.



Honeywell controller prevents loss of pumping pressure

When electrically driven pumps are paralleled with steam-driven standby pumps, automatic switchover in the event of power failure poses a problem. A Honeywell pressure controller, connected as shown above, provides an economical and thoroughly dependable solution . . . automatically cuts the steam pump into service when needed, without interrupting the pumping pressure.

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● **REFERENCE DATA:** Write for your copy of Catalog 8304, "Industrial Controls."

MINNEAPOLIS **Honeywell**

First in Controls

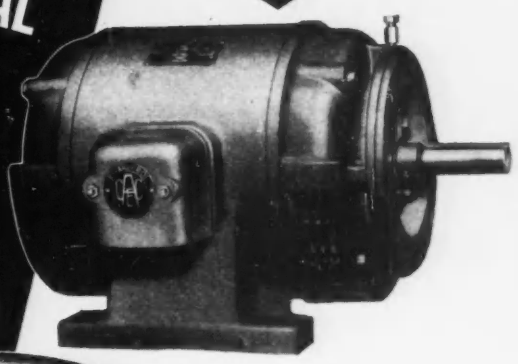
For lower pumping cost per gallon...

choose ACEC VERTICAL and HORIZONTAL PUMP MOTORS

1 hp. to 75 hp. —all available from stock

VERTICAL HOLLOW SHAFT MOTORS
Squirrel Cage—3-phase—Drip Proof—High Thrust—Standard Reverse Protection Clutch—3 to 75 hp. (larger sizes built to order)

TYPE C FACE MOUNTED MOTORS
Squirrel Cage—3-phase—Drip Proof—900 to 3600 rpm—¾ to 50 hp. (larger sizes built to order). Standard or Long Shaft Extension.



TYPE P VERTICAL SOLID SHAFT MOTORS
Squirrel Cage—3-phase—Drip Proof—High Thrust, 900 to 3600 rpm—¾ to 25 hp. (larger sizes built to order)

For dependable operation at a lower cost per gallon, team your pumps with ACEC pump motors. Produced by the WORLD'S FOURTH LARGEST Electrical Manufacturer, ACEC pump motors offer the electrical and mechanical excellence that results from over 70 years of experience and research. Yet they're priced *below* most other motors.

Manufactured strictly to NEMA FRAMES AND SPECIFICATIONS, ACEC motors are available *from stock* in branches and warehouses located in New York, Chicago, Kansas City, New Orleans, Houston, and Los Angeles. And a nation-wide network of 300 DISTRIBUTORS AND SERVICE SHOPS assures prompt and efficient servicing.

For top-level motor performance and utmost motor dependability *at lower prices*, contact our main office and we will have our nearest representative call you.

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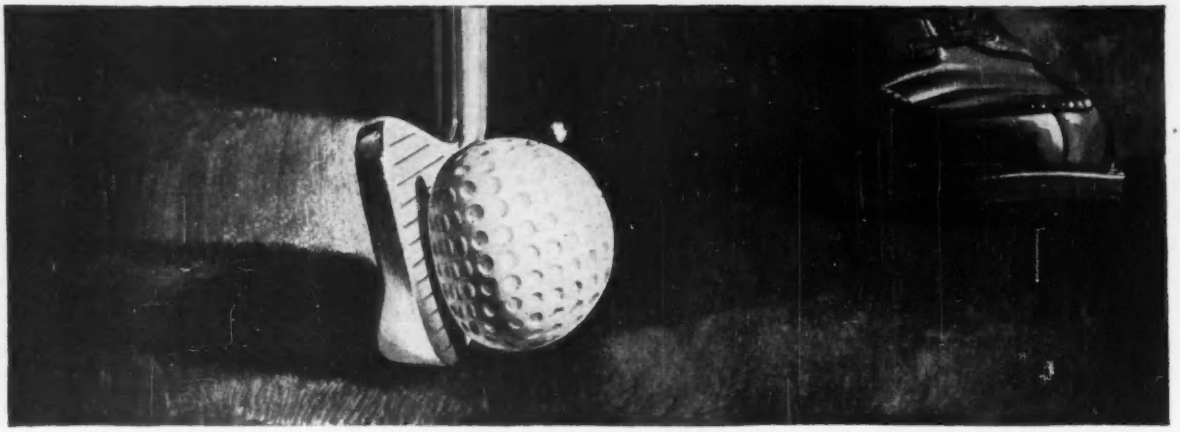


The expert's materials work with him!

Superior skill lies behind the shots of the expert golfer. But, he's also very careful in his selection of clubs. They must be shaped from good materials and balanced to his satisfaction. He takes care that the materials of his business are going to work *for* him and *with* him.

Add this Spec to Your Blueprints

Memorandum

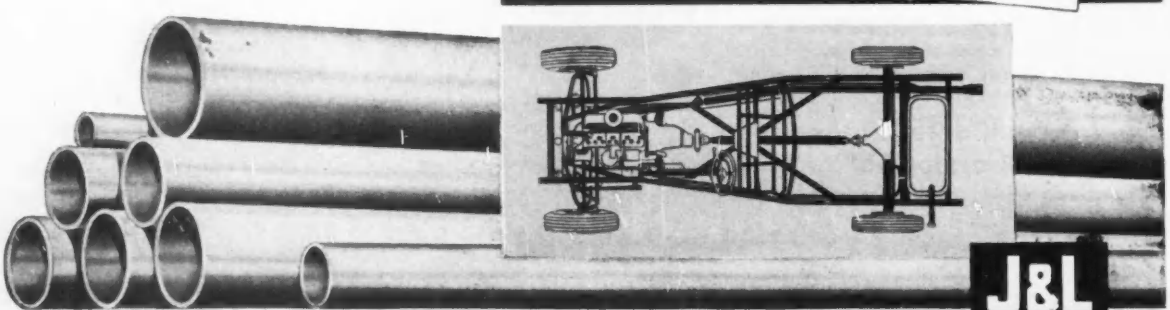
You can depend upon J&L ELECTRICWELD TUBING . . . it works *for* you and *with* you! It's made from J&L steel of carefully controlled quality.

You can depend upon J&L Electricweld Tubing for:

1. Uniform wall thickness (easy forming)
2. Strength (comparable in strength to heavier sections)
3. Ductility (easier, faster fabrication)
4. Reductions in weight (less weight in proportion to strength)
5. Smooth surface (ideal base for electro-plating, enameling, and painting)
6. Ready joining (by mechanical or welding methods)
7. Lower costs (savings in material and overall production costs)

**All standard lengths . . . diameters . . . wall thicknesses for the modern car*

WHEN YOU NEED TECHNICAL ASSISTANCE . . . call J&L. Our metallurgists can investigate your problem and suggest helpful applications of Electricweld Tubing.



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J&L STEEL

TAYLOR ***Insulation (Fish Paper)***
is extremely tough . . . has high dielectric strength and excellent bending qualities . . . its hard surface resists abrasion from contact with rough spots in slots.

Want to make something of it?

Make it into armature slot insulation, armature end laminations, field coil insulation, metal box liners, washers, arc shields, formed slot wedges, formed specialties . . . or any other applications requiring excellent electrical characteristics. Color: gray.

Make it from sheets and rolls . . . or ribbon rolls for automatic machines.

SPECIFICATIONS

Thickness range . . . .005" to ½"	Roll width 56" in thicknesses of .005" through .090". Coils down to ¼" for thicknesses of .005" through .090".
Finish. Calendered or uncalendered	
Punching . . . . . Up to ½"	
Sheet size . . . . . 56" x 90"	

PROPERTIES

Mechanical

Tensile Strength, psi	
(Lengthwise)	14000 min.
(Crosswise)	6000 min.

Elmendorf Tearing Strength, grams

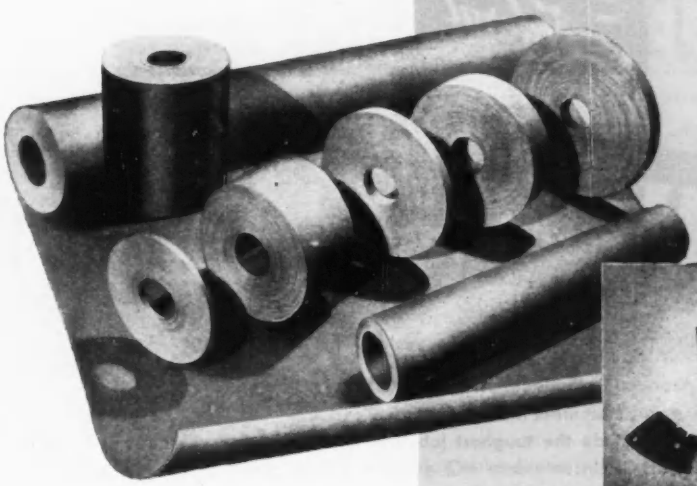
	*MD	*CD
.005"	100	120
.007"	190	220
.010"	250	300
.015"	375	450

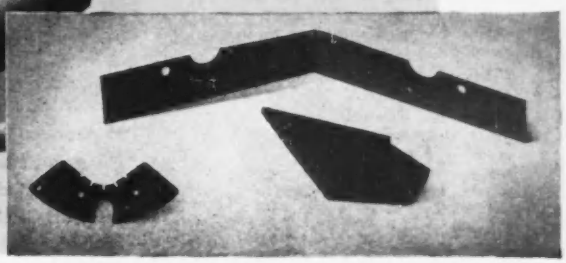
*MD—Machine Direction
*CD—Cross Machine Direction

Electrical

Dielectric Strength, vpm
Short Time Test

.004"—.005"	200 min.
Over .005"—.015" incl.	300 min.
Over .015"—.040" incl.	250 min.
Over .040"—.060" incl.	175 min.
Arc Resistance, seconds	100





Make it easy for yourself the next time you are buying insulation. Call your Taylor Engineer . . . he will be glad to help you select the Taylor Insulation that will best fit your needs. Also ask him for samples of our other grades of vulcanized fibre—Commercial, Bone, Super White, Abrasive and Built-Up —as well as Taylor *Phenol, Silicone and Melamine Laminated Plastics* . . . see where they can fit into your design plans.

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APPLICATIONS

LIQUID LEVEL CONTROLS • STOP MOTIONS • SAFETY ALARMS
DROP WIRE DETECTION • ETC.

FEATURES

- **SENSITIVE** — Relay action initiated by external contact as high as ONE HALF MEGOHM with current as low as 1/10,000 ampere.
- **SMALL SIZE** — Mounts on a standard 4 inch electrical connector box.
- **DEPENDABLE** — Simplified circuit, plus silver relay contacts assures long service life.
- **ECONOMICAL** — Cold cathode tube eliminates power consumption during "off" cycle.
- **VERSATILE** — High contact pressure on silver contacts allows conservative rating of four (4) amperes, with a choice of either opening or closing a circuit, or to simultaneously open one and close another.
- **AUTOMATIC HOLD CIRCUIT** — Connecting terminals provide a choice of conventional relay action, or allow a momentary contact to energize relay and cause it to remain energized until manually released by "Reset" switch.
- **POWER INPUT** — 115 volts, 60 cycles, single phase.

$19.75 in single lots
IMMEDIATE DELIVERY FROM STOCK
Prices F.O.B. Hawthorne

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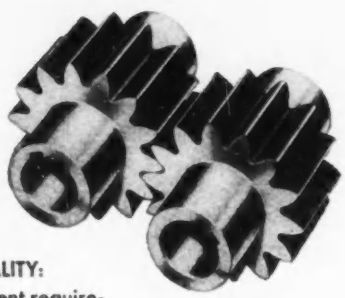

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You'd normally see this →

but not with the "LEVEL-LOAD" axle!

An axle that evenly distributes load weight on both springs—*regardless of load placement*—can't help but offer makers of towed equipment more freedom of design and layout. And it's here now . . . the ASF-Linco "Level-Load" axle!

Each end of this unique axle has a spring-controlled floating spindle arm, forged as a solid, integral unit with the steel shaft. Road shock on one wheel, or an off-center weight, is absorbed by both springs—*equally and simultaneously*. The inevitable result is a load that stays level without tilting or sidesway; a load that tracks better and pulls evenly on the drawbar.

And, as the spindle arm moves downward with increased loads, spring leverage *decreases*. Spring tension and load weight are automatically maintained in easy-riding proportion to each other!

If you design any kind of towed equipment . . . welding machines, sprayers, utility trailers, mixers, etc. . . . get all the facts on towing at its level best! Write American Steel Foundries, 410 North Michigan Avenue, Chicago 11, Illinois.

The NEW axle that adds NEW features to towed equipment!

Load Stays Level—No tip, no sidesway to cause uneven drawbar pull.

Easier Riding—With spring tension that automatically adjusts to load weight.

Bigger Capacity—Than any other axle of similar rating.

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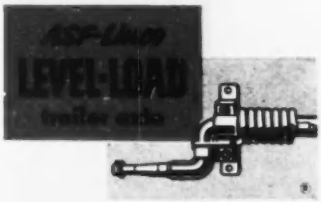

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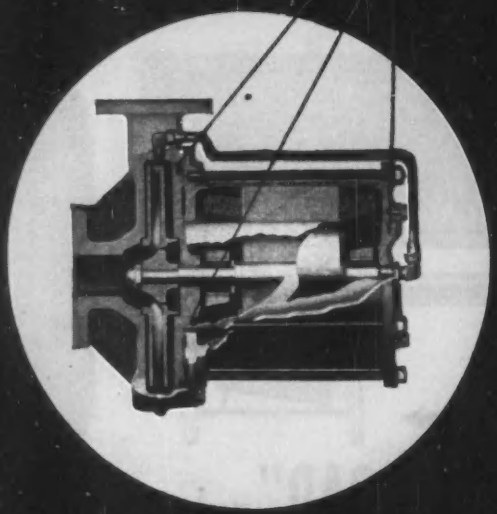
simplify design . . .



. . . speed assembly of "packingless" pump

Through ingenious use of Linear O-rings, the unique "Chempump" ends all sealing problems. Designed for corrosive liquids, this pump allows pumped fluid to circulate through the rotor chamber... eliminates stuffing boxes and their leakage, adjustment and friction troubles.

Linear O-rings provide the ideal way to put this design idea to work. A pair of them seal off the stainless steel cylinder that surrounds the rotor, and another seals the impeller housing in place. They prevent fluid from leaking into the stator windings, by means of a seal that never needs adjustment . . . takes extremely little space . . . is quick to assemble and disassemble . . . and is far simpler and safer than other packings.

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Lower cost, smaller size Mac-it Screws can be used for all fastening jobs because of their exceptional tensile and torsional strength. Made from special Mac-it Alloy Steel held to rigid specifications, Mac-it Screws insure uniform and dependable screw performance.

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Manufactured by Mac-it Parts Co., Lancaster, Pa.

Contact your nearest Mac-it Distributor or the Home Office, Cleveland, Ohio, for full information on how Mac-it can solve your screw problems.

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technical bulletin

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WEIGHT

Greater output per pound is the constant objective of the aircraft designer. EEMCO serves this goal by turning out new electric motors with increased power, decreased weight and all the required operating characteristics. This tough new lightweight for driving a compressor was built to the latest Army and Navy specifications. Operating on 27 volts D.C., it provides 3 horsepower under continuous duty at sea level, 2½ h.p. at 50,000 feet with duty cycle of ½ hour on—½ hour off. It weighs only 13½ pounds with integral gear box of 2¾ to 1 reduction.

Doubled plant capacity and new facilities enable EEMCO to keep pace with the growing need for these specialized designs. Today EEMCO motors and actuators are found on virtually all U. S. Aircraft.

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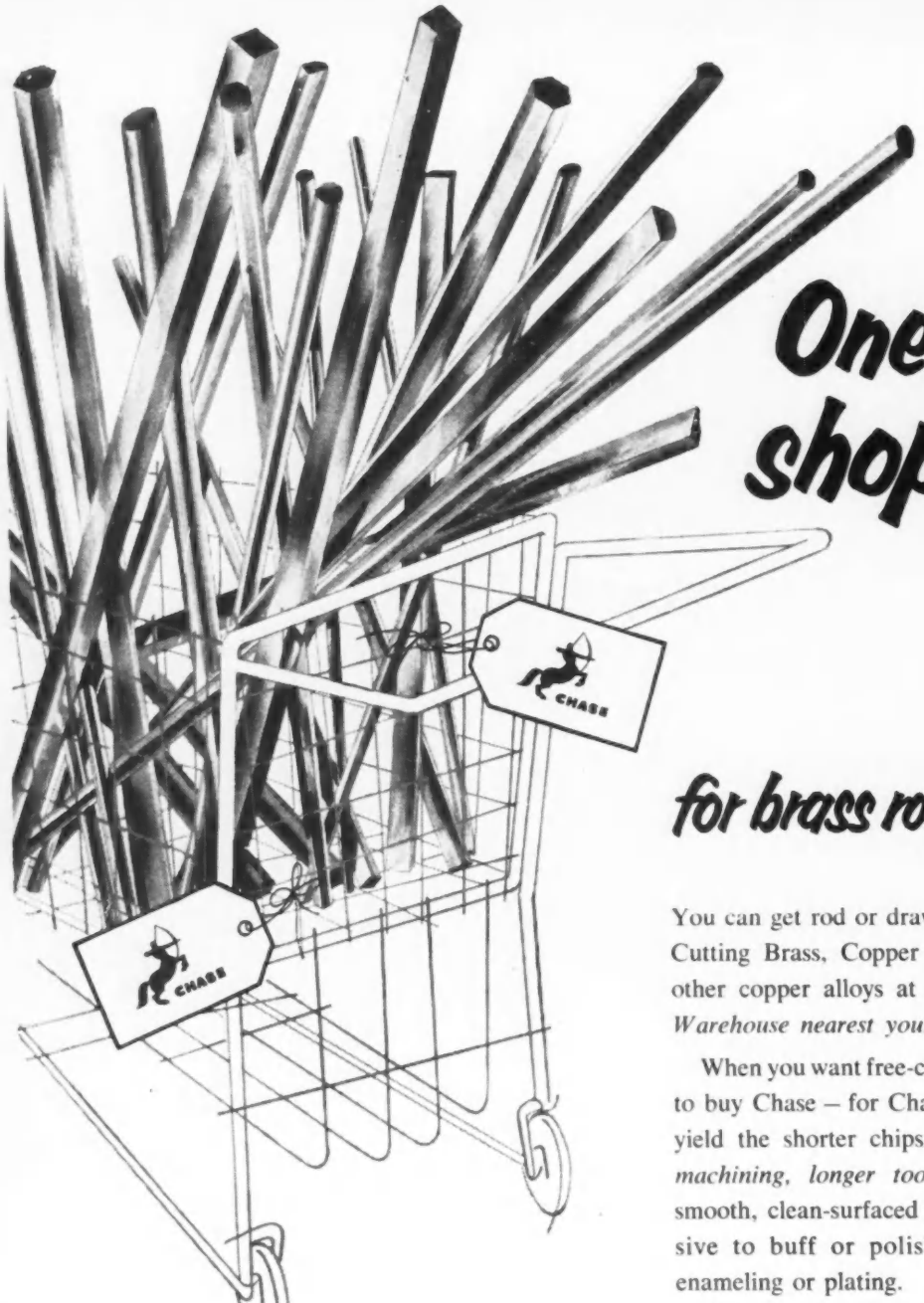

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for brass rod and bar

You can get rod or drawn bar of Chase Free-Cutting Brass, Copper or a wide variety of other copper alloys at one stop – *the Chase Warehouse nearest you!*

When you want free-cutting materials, it pays to buy Chase – for Chase rod and drawn bar yield the shorter chips that make for *easier machining, longer tool life.* They produce smooth, clean-surfaced products – less expensive to buff or polish before lacquering, enameling or plating.

And when it comes to re-ordering, remember that Chase alloys are uniform – repeat orders of the same alloy always have the same cutting characteristics.

Chase BRASS & COPPER

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The Nation's Headquarters for Brass & Copper

Albany†	Cleveland	Kansas City, Mo.	New York	San Francisco
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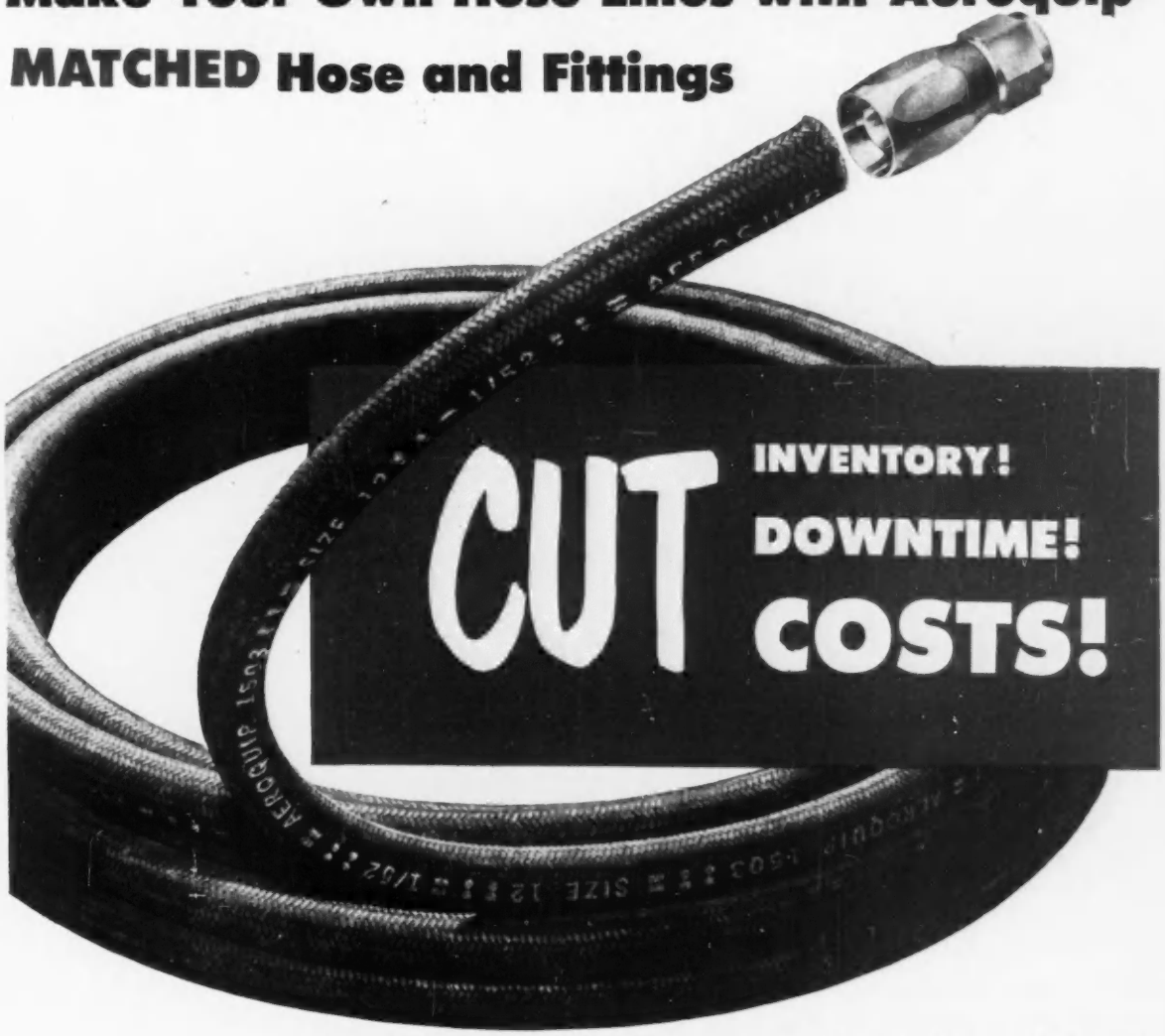
Cincinnati	Indianapolis	New Orleans	St. Louis	office only)

Make Your Own Hose Lines with Aeroquip MATCHED Hose and Fittings



Aeroquip Fittings are designed, developed, and produced to go with Aeroquip Hose. They form such a foolproof combination that Aeroquip *guarantees* performance. Thus, the hose lines made right in your own plant always measure up to Aeroquip's exacting standards of quality, the highest in the industry. A small supply of Aeroquip Bulk Hose and Fittings assures you of quick hose line replacements at all times . . . and Aeroquip Fittings are detachable and may be used again and again when making new hose assemblies.

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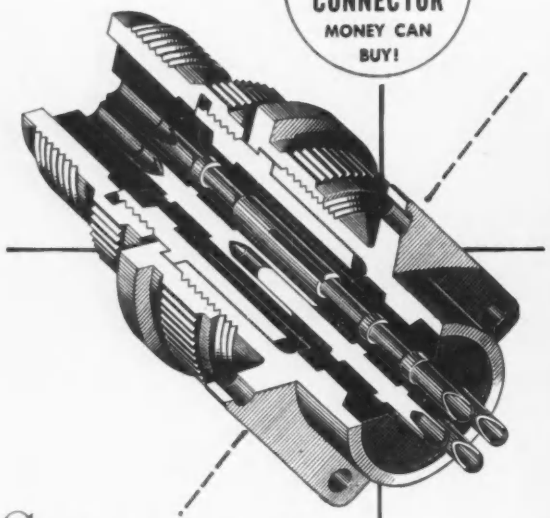
SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA. MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

The Finest
ELECTRICAL CONNECTOR MONEY CAN BUY!



SCINFLEX **ASSURES**
LOW MAINTENANCE BECAUSE
IT PERMITS SIMPLICITY

When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of −67°F to +275°F. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

• Moisture-Proof • Radio Quiet • Single Piece Inserts • Vibration-Proof • Light Weight • High Insulation Resistance • High Resistance to Fuels and Oils • Fungus Resistant • Easy Assembly and Disassembly • Fewer Parts than any other Connector • No additional solder required.

BENDIX SCINFLEX
ELECTRICAL CONNECTORS

Bendix

SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.
FACTORY BRANCH OFFICES: **118 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • Brouwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California**

DROP FORGINGS

It's wise to specify Ritco Bright Finish Drop Forgings when accurate parts of topmost strength are required. These forgings are produced to your blueprint in steel or non-ferrous metals, in weights from 1 4 lb. to 15 lbs. They're smooth and flash-free, require a minimum of machining before assembly into your product.

Come to RITCO for drop forgings, special fasteners, and finished bolts with regular or heavy heads. We also offer complete facilities for finishing—machining and grinding. Estimates gladly submitted. Rhode Island Tool Company, 148 West River Street, Providence 1, Rhode Island.

RITCO

EXCLUSIVE NEW ENGLAND REPRESENTATIVES FOR CLEVELAND CAP SCREWS

★ SERVING AMERICAN INDUSTRY SINCE 1834 ★

SYNTHANE — making bigger payloads pay off

Synthane bushings, spacers, and bearings in the landing gear of this giant of the skies share the landing shock loads of twenty-five tons. But Synthane parts have many virtues in addition to their ability to withstand the jolts of heavy landings.

Parts made of this hard-working laminated plastic are unaffected by oils, and are dimensionally stable. They resist abrasion, and weigh half as much as aluminum.

Because Synthane is so easy to machine, it is appropriate for fair-leads and cable-sheaves in control systems. Because it is an excellent electrical insulator, you will find it at work in engine ignition systems, flight instruments, automatic controls, and radar sets. Because Synthane is light and corrosion-resistant, it's used for the flapper valves in fuel cell baffles.

Synthane has all these properties and many more. It might be a good material for you to try. Start by sending for the complete Synthane Catalog. Synthane Corporation, 6 River Road, Oaks, Penna.

IS YOUR ANSWER HERE?

If you are not in the aircraft industry, Synthane's combination of properties may still stir your interest. Besides the properties at the left, Synthane has good tensile, compressive, flexural, impact and shear strength, a low coefficient of expansion, is moisture- and wear-resistant, easy to machine.

Sliding component for handrail of moving stairway, machined from Synthane.

Breaker arms in distributor contain molded-laminated Synthane.

Synthane—one of industry's unseen essentials

SYNTHANE

LAMINATED PLASTICS

In hydraulic pumps

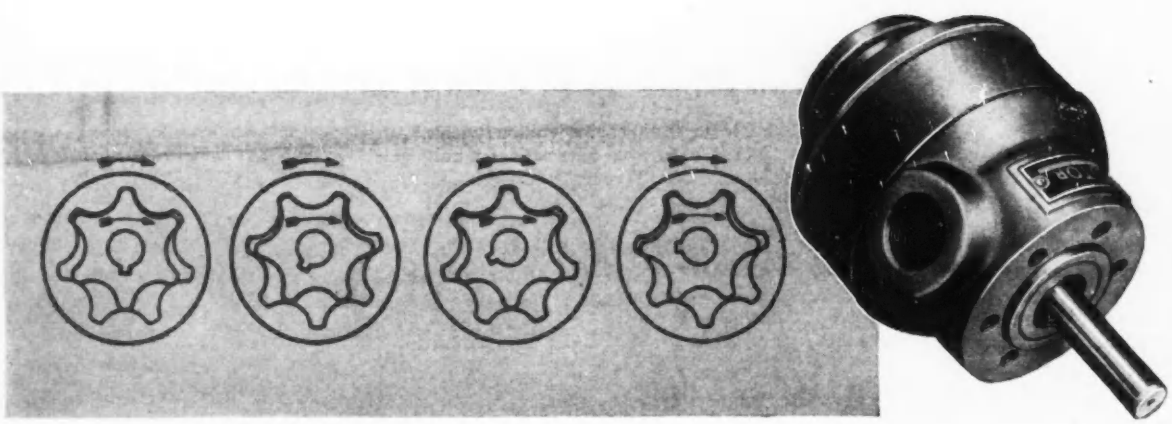
GEROTOR

is more than a name . . .

it's the principle of the thing!

The unique Gerotor principle operates with high volumetric and mechanical efficiency. Both gear-shaped Gerotor elements revolve in the same direction at low relative speed, resulting in less wear, longer life. Continuous fluid-tight engagement means less slippage, more uniform flow. See relative advance of teeth and spaces below.

Gerotor hydraulic pumps are engineered for pressures up to 1000 p.s.i. continuous duty; in some sizes, up to 1200 p.s.i. continuous and 1500 intermittent. Deliveries range from .4 g.p.m. at 1800 r.p.m. to 40 g.p.m. at 1200 r.p.m. Plain, base or flange mounting. Write for pump catalog. GEROTOR MAY CORP., P. O. Box 86, Baltimore 3, Md.



GEROTOR hydraulic pumps & motors

DESIGNING WITH ALUMINUM

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

NO. 2 THERMAL CONDUCTIVITY, REFLECTIVITY

CONSIDER USE OF ALUMINUM ALLOYS WHERE HEAT CONDUCTION OR RADIANT HEAT REFLECTION IS REQUIRED

At first glance it may appear to be a paradox that aluminum is both a good thermal conductor and a good reflector of radiant heat, but two separate phenomena and properties are involved.

Conduction is the process of heat transfer through a material by kinetic energy. Radiation is the transmission of energy from a source to a receiver through space by electromagnetic waves; those chiefly responsible for heat radiation are similar to but of no longer wave length than those for light. When absorbed, the radiant energy increases the temperature of the absorbing body.

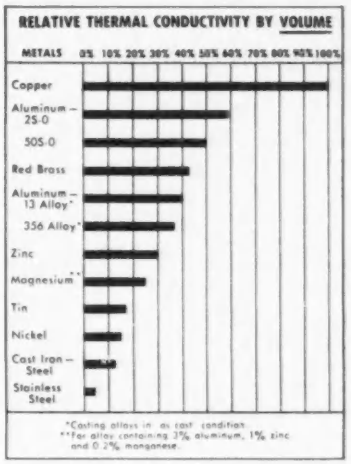
The possession of these two distinct properties—thermal conduction and radiant reflectivity—has proved of outstanding value in many successful applications of aluminum, especially as they are combined with such other properties of aluminum as corrosion resistance, light weight and strength, workability and economy.

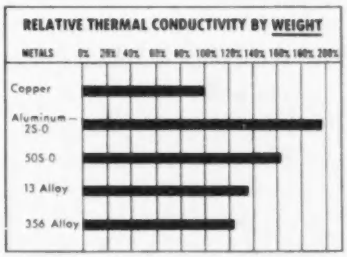
Aluminum best conductor on weight basis

Of the commercial metals aluminum ranks second only to copper in thermal conductivity on a volume basis. On a *weight* basis, however, aluminum has the highest thermal conductivity, with various aluminum alloys being superior to copper by a wide margin.

The relationship between some aluminum alloys and other metals with respect to thermal conductivity, as illustrated in the charts in the next column, shows why aluminum is worth considering where it is necessary to conduct or dissipate heat.

Localized "hot spots" resulting from use of a metal of inferior conductivity are troublesome and reduce efficiency, whether they occur in a cooking utensil or in a more complex application.





How aluminum's high thermal conductivity can greatly improve efficiency is demonstrated by its use in internal combustion engines, where one of the major problems is high temperature in the engine envelope. By dissipating heat rapidly, aluminum cylinder heads reduce temperature in the combustion chamber by as much as 100° F., thereby making it possible to obtain higher compression ratios by preventing detonation caused by a "hot spot." It has been found also that aluminum cylinder liners surfaced with hard plating have given a very considerable power increase over cast iron liners because of better heat dissipation.

More and more, the trend is toward greater utilization of aluminum to produce higher performance engines. In fact, power plants made almost entirely of aluminum are built not only for aircraft but also for marine application, tanks, trucks and such popular, work-saving products as power lawn mowers and portable chain saws. The light weight, corrosion resistance and workability of aluminum are beneficial as well in their design, manufacture and operation.

The thermal conductivity properties of aluminum also play a part in its use in torque converters (discussed in No. 1 of this information series, dealing with "Light Weight with Strength") by eliminating the need to make special provision for cooling to handle heat generated during operation.

An interesting specialized use of aluminum's conductivity, made practical because aluminum can be economically rolled to thin foil, is seen in cigarette-proof tables, desks and counter tops. A layer of foil just beneath the surface dissipates heat from the burning tip of a carelessly laid cigarette so rapidly that there is no scorching or burning.

Aluminum reflects short, long waves

Aluminum is highly reflective to both short wave (solar) and long wave radiant energy. Possession of this quality means also that aluminum is characterized by low absorption of solar heat and low emissivity, or radiation, of long waves.

PLEASE TURN TO NEXT PAGE ➡

In per cent, reflectivity plus absorption, or reflectivity plus emissivity, equals 100. Although polished aluminum surfaces such as bright aluminum foil have the highest reflectivity, up to 95% or 97%, even aged mill finish aluminum sheet retains this property to a marked degree.

The table below gives approximate values of these properties for aluminum in comparison to some other surfaces:

EMISSIVITY, ABSORPTION OF VARIOUS MATERIALS

	Long Wave Emissivity in %* (Radiation)				Solar Absorption in %* (Short Wave)	
	50-150°F New	50-150°F Aged	1000°F New	1000°F Aged	New	Aged
Bright Aluminum Foil	3	5	5	10	5	15
Bright Aluminum Roofing Sheet	5	20	10	20	20	40
Mill Finish Aluminum Sheet	8	20	11	20	25	40
White Paint (Flat)	85	95	60	75	12	50
Colored Paint	85	95	..	..	65	88
Galvanized Iron	10	60	..	..	30	90
Black Non-Metallic Surfaces	87	98	..	..	85	98
Window Glass	90	95	..	..	Transparent**	
Wood	90	98	..	..	98	..
Steel Sheet	65	90	80	97	..	..

*Per cent reflectivity is 100% minus value listed.
**Actually reflects about 8% of sun's rays.

Reflectivity useful in varied ways

Inasmuch as radiant heat is frequently the major source of the total heat load, examination of these values shows why designers in various fields are making more use of aluminum to solve different problems.

It is obvious also how an aluminum roof makes a building cooler in summer—it reflects a high percentage of the solar heat, and only a small percentage of what is absorbed is reradiated by long-wave emissivity to the interior—and why aluminum foil makes excellent reflective insulation, whether new and bright or old and dusty.

Other ways in which the heat reflective property is being used with substantial benefit include reflective shields behind radiant heaters, radiant heat baffles in residential furnaces and radiant heat shields to protect workers who must tend high-temperature industrial furnaces.

Because of its low emissivity, a heating duct made of bare aluminum delivers more heat than other standard types of duct construction. Comprehensive tests (report available on request) between 12-inch diameter round ducts approximately 100 feet long showed that a duct made of new aluminum gave a temperature drop of only 43° F., as compared with a 61° drop for an asbestos paper covered galvanized duct.

It is possible, if so desired, to achieve directional radiation by painting or otherwise coating one side of aluminum and leaving the other side bare. When the metal is heated, the painted side will radiate heat but the bare side will emit little heat.

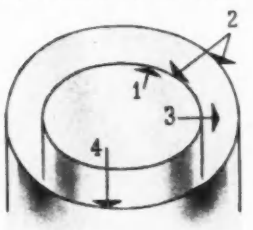
Better vent and flue pipe of aluminum

Use of aluminum in a double-wall construction, essentially an inner and outer pipe of aluminum sheet separated by a ventilated air space, has resulted in a highly efficient gas vent and flue pipe that fully meets Underwriters' Laboratories, Inc., Type B requirements without restriction.

The properties of aluminum as well as its design contribute to the value of this pipe. The inner pipe, being of small thermal mass (and of high conductivity, though that is of less importance), rises quickly to temperature when the gas appliance is turned on; it provides quick, strong draft, thorough removal of flue gases and elimination of condensation.

Maximum insulation is provided by the low emissivity of both inner and outer pipes in conjunction with the insulative properties of the air space between them. The result is that this type of pipe keeps adjacent wood surfaces from exceeding 90° F. above room temperature, the UL limit, even when flue gas temperature is at the American Gas Association-permitted maximum of 550° F. In other words, aluminum makes possible *a safer as well as a better operating construction* than other commonly used materials. Other advantages from the use of aluminum are light weight with easier installation, durability through freedom from cracking or breaking, resistance to corrosive influences, and economy.

HOW ALUMINUM VENT PIPE WORKS



1. Inner pipe heats rapidly.
2. Low emissivity of outside surfaces of both pipes provides minimum radiation.
3. Ventilated air space provides high insulation.
4. Inside surface of outer pipe reflects radiant heat.

Where heat flow occurs, investigate aluminum

If heat transmission or reflection is involved in a design and application problem, it will pay to investigate the use of aluminum alloys. Along with high conductivity or reflectivity, other aluminum properties will provide additional benefits.

Kaiser Aluminum engineers experienced in product design, development and fabrication will gladly assist you in getting the most from aluminum's unique combination of properties. Call or write any Kaiser Aluminum office, in principal cities. Kaiser Aluminum & Chemical Sales, Inc., Oakland 12, Calif.

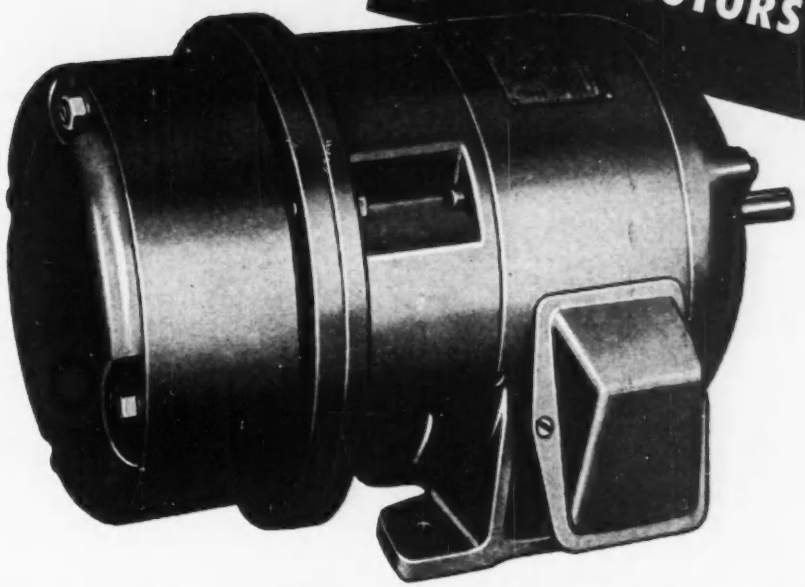
Kaiser Aluminum

see our catalog in PRODUCT DESIGN FILE or write for copy

Setting the pace . . . in growth, quality and service

Split-second STOPS call for...

ELLIOTT
CROCKER-WHEELER
BRAKE MOTORS

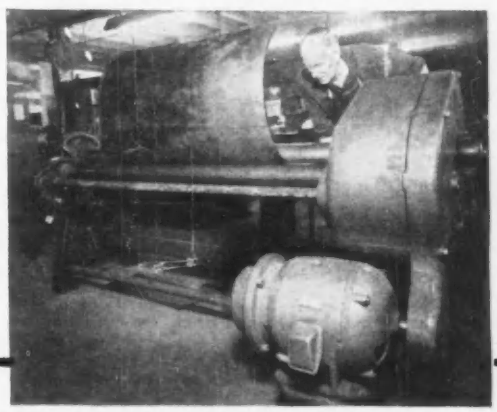


Here's a brake that has everything demanded of the most exacting service. Check over these valuable features:

NEW "CLOSE-COUPLED" COMPACTNESS that not only enables it to fit in limited space, as in machine tools and similar equipment, but also provides the rigidity and sturdiness to take the stress of constant sudden stoppage.

TORQUE ADJUSTMENT FROM THE OUTSIDE OF THE CASE.

TYPICAL APPLICATION — This roll-forming machine has to stop movement of the work exactly on a layout line. The Elliott Crocker-Wheeler brake motor does the trick.



W3-1

PRACTICALLY NON-WEARING BRAKE ACTION, with metal-to-metal contact of "Velvetouch" discs and stationary plates for greater friction, quicker stops, and entire immunity to heat, cold, dampness, fungi, oil or grease.

QUICK-REMOVABLE WRAP-AROUND COVER enables inspection of all brake parts from the side of the brake.

SUPERIOR MAGNET CONSTRUCTION, up to the highest Crocker-Wheeler standards.

If you want a free-running brake that clamps down to an instantaneous dead-on-the-line stop when the power clicks off, this is it.

The Elliott C-W brake can be supplied with Crocker-Wheeler integral motor. It is also available as a separate unit for mounting on double shaft extension NEMA standard D flange motors, frames 203-326 or C face motors, frames 364-405. It needs no mounting brackets nor adapters.

GET THE BRAKE MOTOR BULLETIN

Ask your local Elliott field engineer, or write Elliott Company, Jeannette, Pa.

ELLIOTT Company

CROCKER-WHEELER DIVISION

SUB-MINIATURE
PILOT LIGHTS
Approved for AIRCRAFT
AND IMPROVED IN IMPORTANT DETAILS

DIALCO

A great aid to your miniaturization program

SUB-MINIATURE INDICATOR ASSEMBLIES

NON-DIMMING
No. 8-1930-621

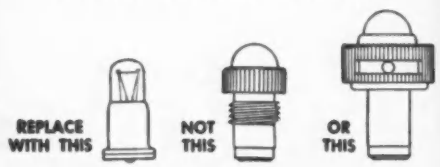
MOUNT IN 15/32" HOLE
ALL LENS COLORS

Easy lamp replacement with any midget flanged base lamp types

Complete blackout or semi-blackout dimmer types

MECHANICAL DIMMER
No. 11-1930-621

THESE ASSEMBLIES LOGICALLY REPLACE LAMPS NO. 319, 320, and 321



PLASTIC PLATE (EDGE) LIGHT ASSEMBLIES

AIR FORCE and BUREAU of AERONAUTICS
MIL-L-7806 DRAWING MS-25010

DIALCO *No. TT-51* (Red filter-black top) or, *No. TT-51A*, complete with No. 327 Lamp

ALSO MADE
with other filter colors and with *light-emitting top* (for indication)

ALL OF THE ASSEMBLIES ILLUSTRATED ACCOMMODATE LAMPS NOS. 327, 328, 330, and 331.

ANY ASSEMBLY AVAILABLE COMPLETE WITH LAMP

SAMPLES ON REQUEST — NO CHARGE

Foremost Manufacturer of Pilot Lights
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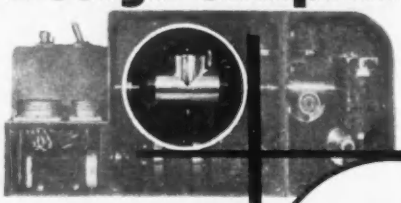
THE *Finest* TRACING CLOTH

Imperial is known in drafting rooms all over the world as the traditional quality tracing cloth.

With the background of decades of experience, its makers have pioneered in modern improvements to maintain Imperial as the finest tracing cloth made.

Design Simplified...



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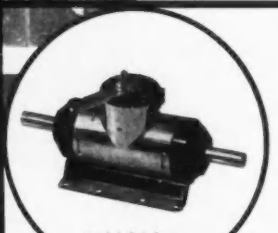
Metron
VARIABLE
SPEED DRIVE

- Permanently lubricated
- Your choice of 6 controls
- Speeds up to 10,000 RPM
- Nominal output .025 HP



Model 3 B lever type control

Design engineers at Century Geophysical Corporation make use of the Metron Variable Speed Changer to give them continuously adjustable chart speeds in their miniature oscillograph.

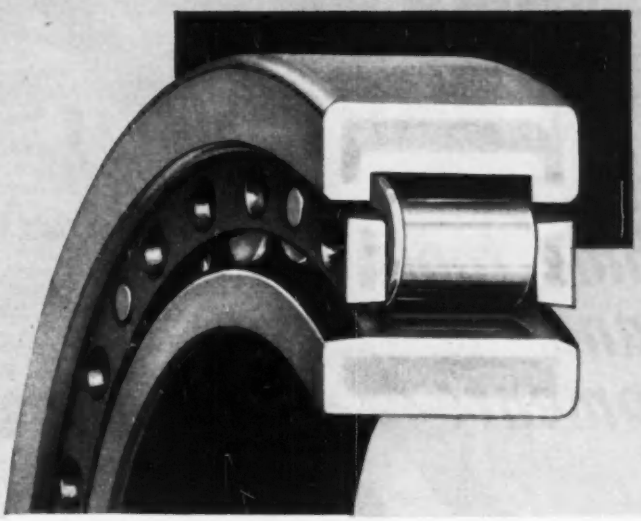
Century engineers find that it is simpler and more economical to use Metron Miniature units as components than to design and build their own.

Metron Variable Speed Changers are designed into countless products that call for changes in speed. The units are small—only 4 3/16" long—to fit minimum space. They are smooth and accurate in operation and cover infinitely variable output speeds from 5:1 step down thru 1:1 to 1:5 step up.

• For further information about how Metron units can simplify your costly speed changing problems, write for Bulletin 99.

Metron
INSTRUMENT COMPANY
444 LINCOLN ST., DENVER 9, COLO.

Bower straight roller bearings carry maximum loads!



TWO-LIP RACE INCREASES RIGIDITY— IMPROVES ROLL ALIGNMENT

Examine the cutaway view of the Bower straight roller bearing, shown above. It is important to note particularly the two parallel lips made integral with the outer race. These lips or shoulders provide a rigid, durable construction—keeping the rolls in proper alignment.

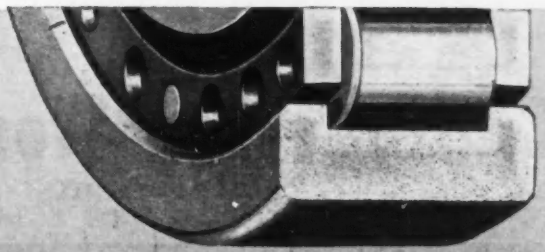
Built of highest quality materials, Bower straight roller bearings have proved themselves capable of standing up day in and day out under maximum loads and the most rugged conditions—with virtually no maintenance whatsoever. They are used extensively in such fields as automotive, earthmoving, farm equipment and heavy machine tool. For the aircraft industry, Bower builds straight roller bearings—especially designed for high-speed, high-temperature operation—which are used by virtually every producer of jet engines.

Whatever you manufacture, you'll build a better product with Bower roller bearings. Write to Bower today. A Bower engineer will give you full details of the complete Bower line.

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN

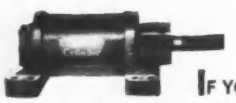
BOWER

ROLLER BEARINGS



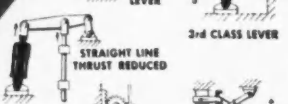
A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS

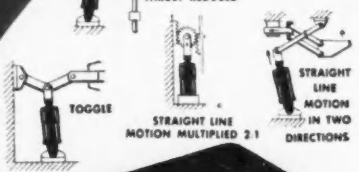
...how can I use HANNA® cylinder power in my machine tools and equipment?



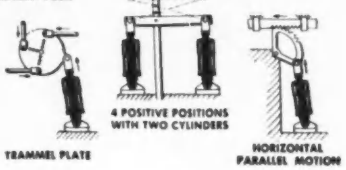
IF YOU HAVE a push, pull, lift, press, clamp or control problem, Hanna Cylinder Power can be the answer. The mechanical movements here illustrated may suggest ways Hanna Cylinders can be used to simplify the actuation and control of machines or equipment and to replace or reduce manual effort.

In the majority of cases, you can select a standard cylinder model to meet your specific requirements from the broad Hanna Hydraulic and Pneumatic lines. Regardless of whether you choose a "standard" or "special" the Hanna label assures you of quality developed through fifty years of concentration on cylinders and their control valves!





here are basic Cylinder Powered MECHANICAL MOVEMENTS that can be put to work for YOU!



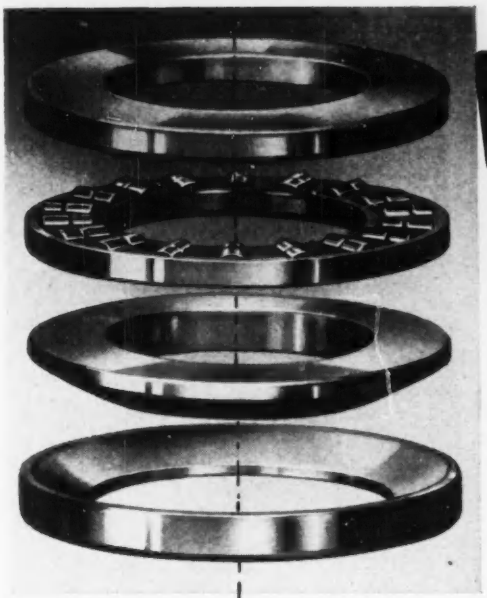
SEND FOR FREE BULLETIN 255

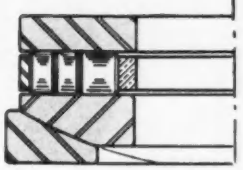
"Cylinder Power in Action" is described in new Bulletin 255. *Write for it today*

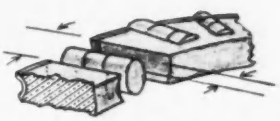
Hanna Engineering Works

1763 ELSTON AVE. • CHICAGO 22, ILL.

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES . . . RIVETERS







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ACCURATE PARALLELISM between the rollers and the matched thrust plates is repeated in the parallelism between the separator slots and the rollers themselves—all adding up to quietness, equalized wear and longer life.

THRUST RADIAL

RIGHT ANGLE
Roller Ends, precisely square to avoid end-rub, oscillation and side-shock.

- **RIGHT ANGLE**
Bearing Surfaces with parallelism that results in unwavering right-line rolling.

- **RIGHT ANGLE**
Separator Slots accurately machined to prevent roller skew, slide and uneven wear.

Held to extremely close limits of parallelism, every roller—every race—every thrust plate in a Rollway Bearing is an engineering masterpiece of matched precision and right-angle trueness. As a result, friction losses are low—load capacity and service life high.

Rollway Radial and Thrust Bearings offer the widest selection in types and sizes, available for quick replacement through authorized distributors. Consult your classified phone directory under BEARINGS.

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Complete Line of Radial and Thrust Cylindrical Roller Bearings

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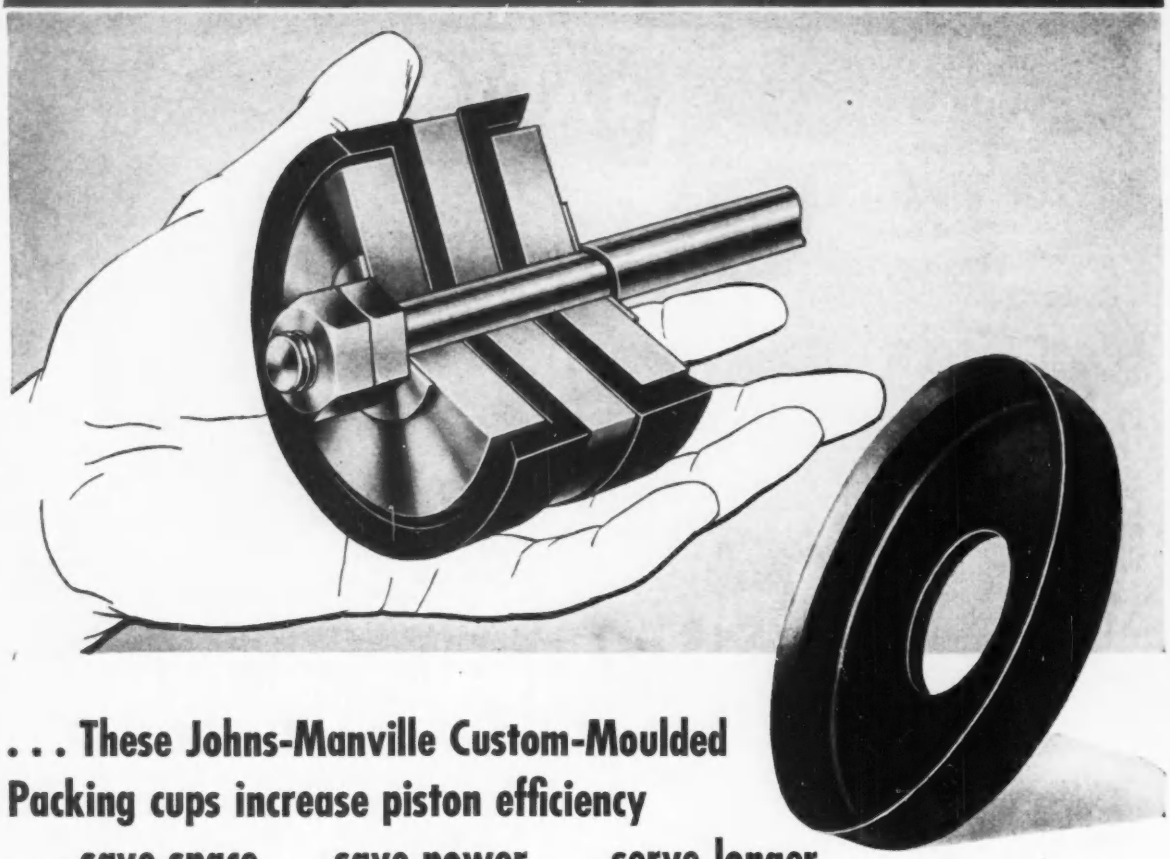
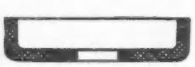


. . . These Johns-Manville Custom-Moulded Packing cups increase piston efficiency . . . save space . . . save power . . . serve longer

TYPE A . . . The Type "A" J-M Moulded Packing Cup is the "standard" for use on the pistons of pumps and on various hydraulic and pneumatic mechanisms. The lip forms a tight seal under discharge pressure, but relaxes on the reverse stroke, reducing friction and conserving power.



TYPE B . . . This type of cup is essentially the same as Type A, except that the leading edge of the lip is square instead of beveled. This construction provides greater strength where the lip may be exposed to distortion or excessive wear due to openings in cylinder walls.

Johns-Manville Moulded Packing Cups can help you improve piston designs. They provide a highly efficient seal . . . improve equipment performance . . . lower operating and maintenance costs. These custom-made packings are extensively used on all types of slow moving pistons and rams operating under high or low pressures and temperatures.

Johns-Manville Moulded Packing Cups may be used on practically all air or hydraulic-operated cylinders. For instance, those which are in such equipment as reciprocating pumps, hydraulic jacks and presses, pneumatic chucks, governors, lift trucks, grease guns, valves, drilling and boring machinery . . . or on any other equipment where efficient piston design is essential.

You have your choice of a number of styles and compositions of these precision-moulded cups to meet temperatures and pressures encountered in hydraulically operated equipment. Types "A" and "B," shown here, are most widely used on inside-packed pistons with the outside edge or lip contacting the cylinder wall or liner. Other types are available, however, for other services.

If you would like more information on these or other types of Johns-Manville Custom-Made Piston Packings, get in touch with your Johns-Manville Packings Distributor, or write Johns-Manville, Box 60, New York 16, N. Y.

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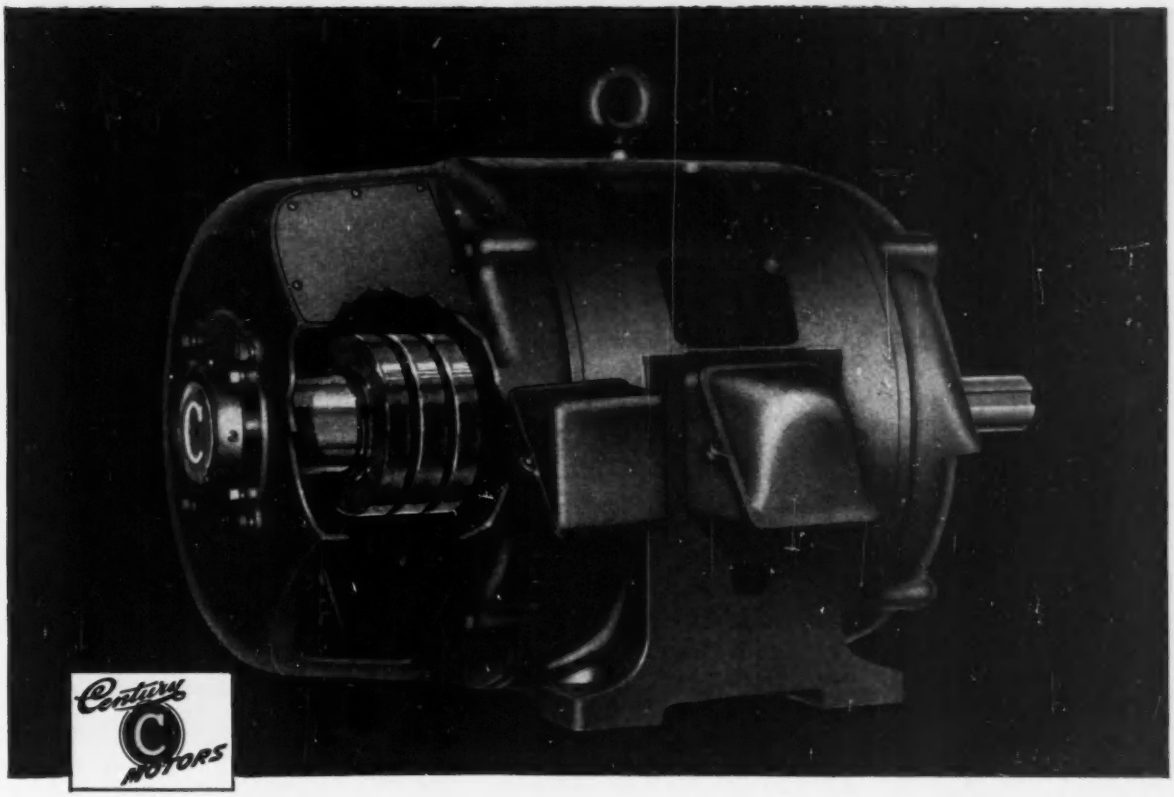
Johns-Manville PACKINGS & GASKETS



perfect contact at high speed

Through Advanced Casting Techniques, We Help Our Customers to Better Serve Their Customers.

Bronze collector rings, like these, are important power transmission factors in electric motors—such as those produced by Century Electric Company, St. Louis, Missouri. Making high speed revolutions with the armature, collector rings must be perfect, as sand inclusions, pits, or other flaws cause arcing, with subsequent loss of motor power.

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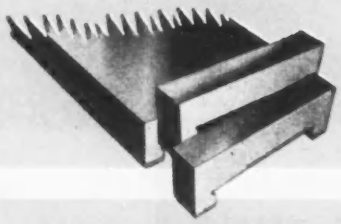

2. Making it into a "tool bit"

3. Then cutting metal with it (1045 cold rolled steel)

The Gisholt Machine Co., Madison, Wisconsin, who use Ohio Knife bedways exclusively on their ram and saddle type Turret Lathes, made the above dramatic test for one of their customers. RESULT—another sale of a famous Gisholt Turret Lathe.

This super uniform hardness on the wear surfaces to a depth of 3/16" (64-66 Rockwell "C") is the reason why more and more OK ways, gibs, races, etc., are being specified on new equipment and used as replacements where former parts have failed. OK ways are practically wear proof assuring constant accuracy throughout the life of your machine. Enjoy with many prominent machine tool builders and users, the long wearing, supreme accuracy, super hardness of OK ways. Many sizes, shapes, etc., available, or made to your specifications.

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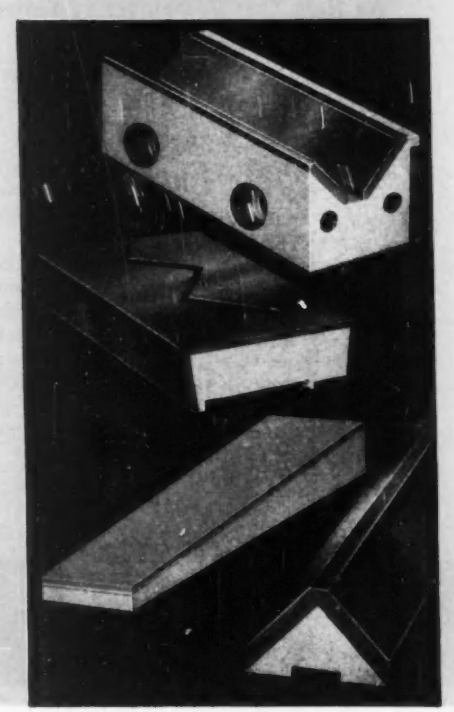
(Reg. U. S. Pat. Office by Ampco Metal Inc.)



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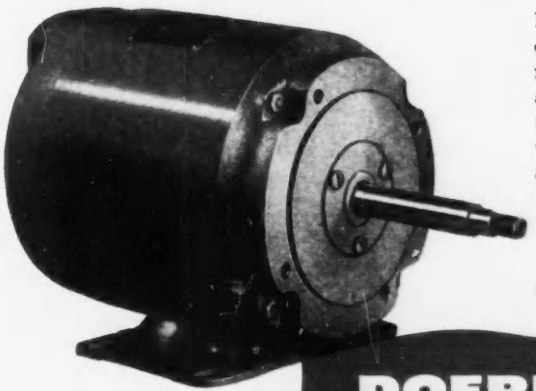

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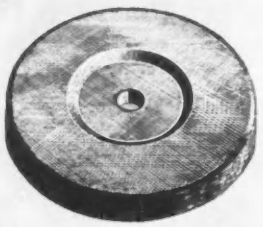
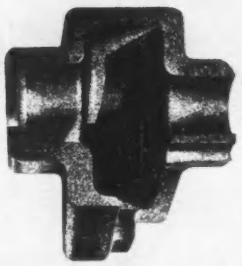


The Black & Decker Mfg. Co.
Resilient pad for power sanding wheel; Molded cellular rubber



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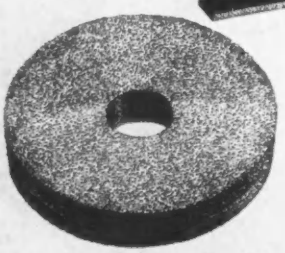

Sanberg Company
Iron lung comfort cushion; Cellular rubber, special soft

Mack Mfg. Corp. Clutch pedal weather seal; Molded cellular rubber

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Electric hand vibrator cushion; Molded cellular rubber

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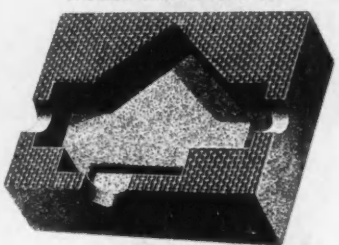

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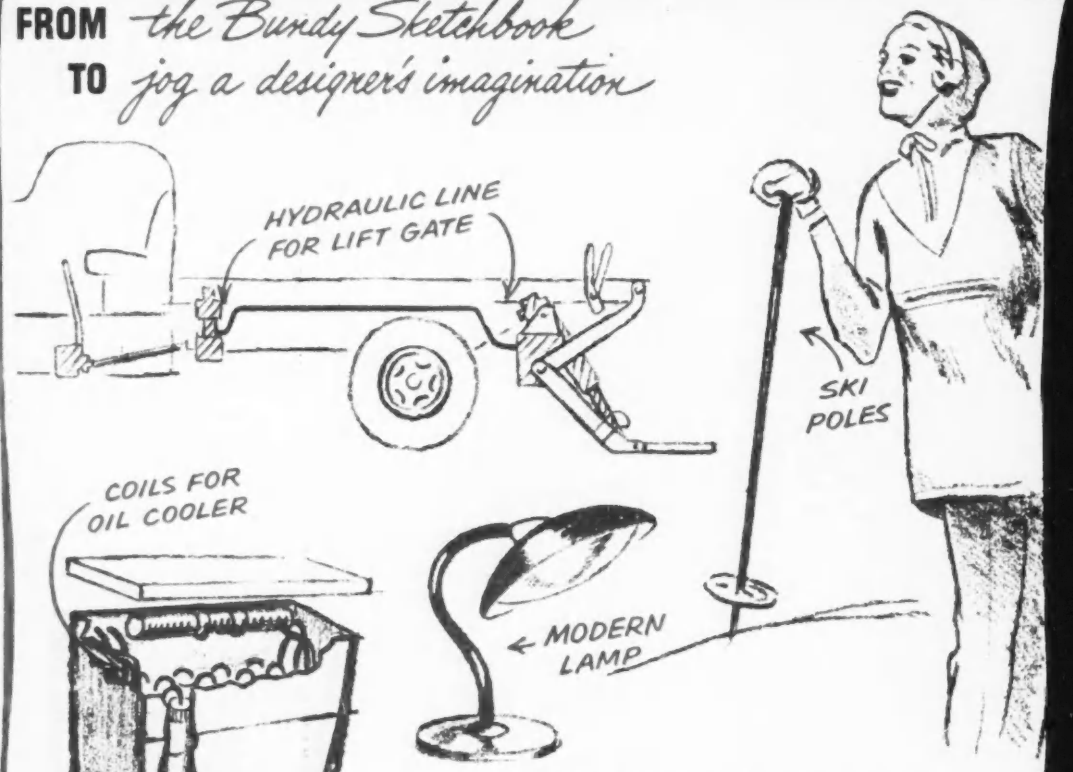
FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*



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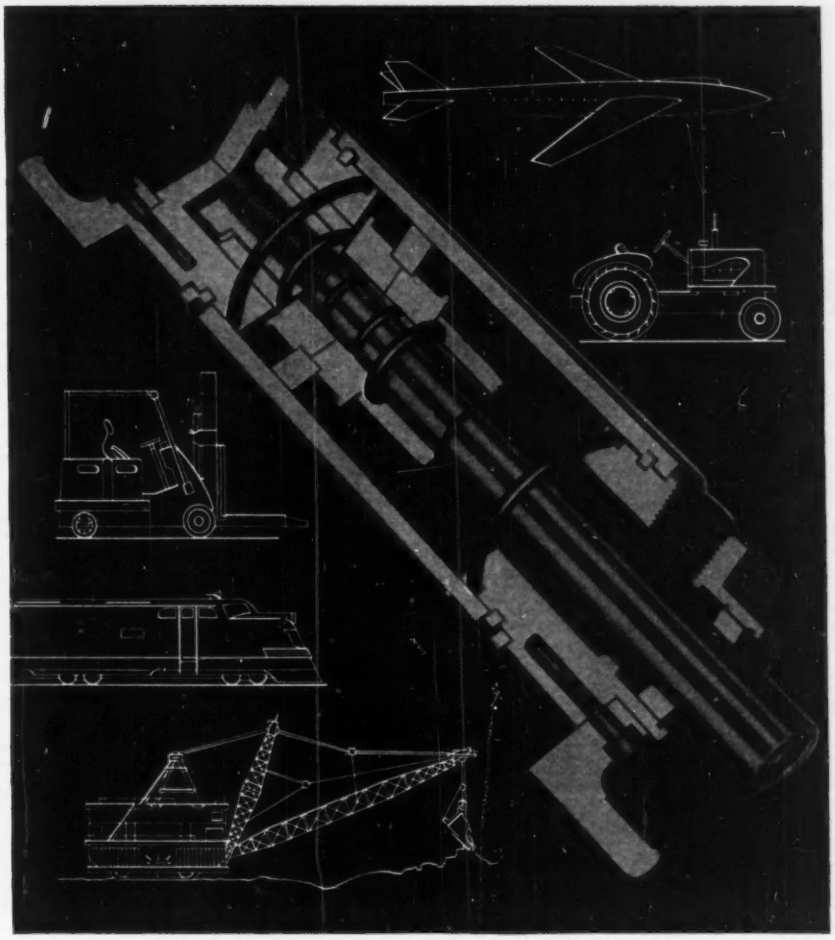
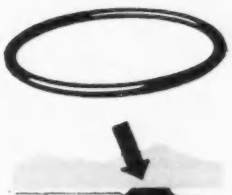


Cutaway view of an Ortman Miller Machine Co. Standard Hydraulic Cylinder showing PARKER O-rings.

Specify PARKER O-rings for economical, leakproof seals

THIS IS IT



Cross section drawing of O-ring in groove, sealing under pressure.

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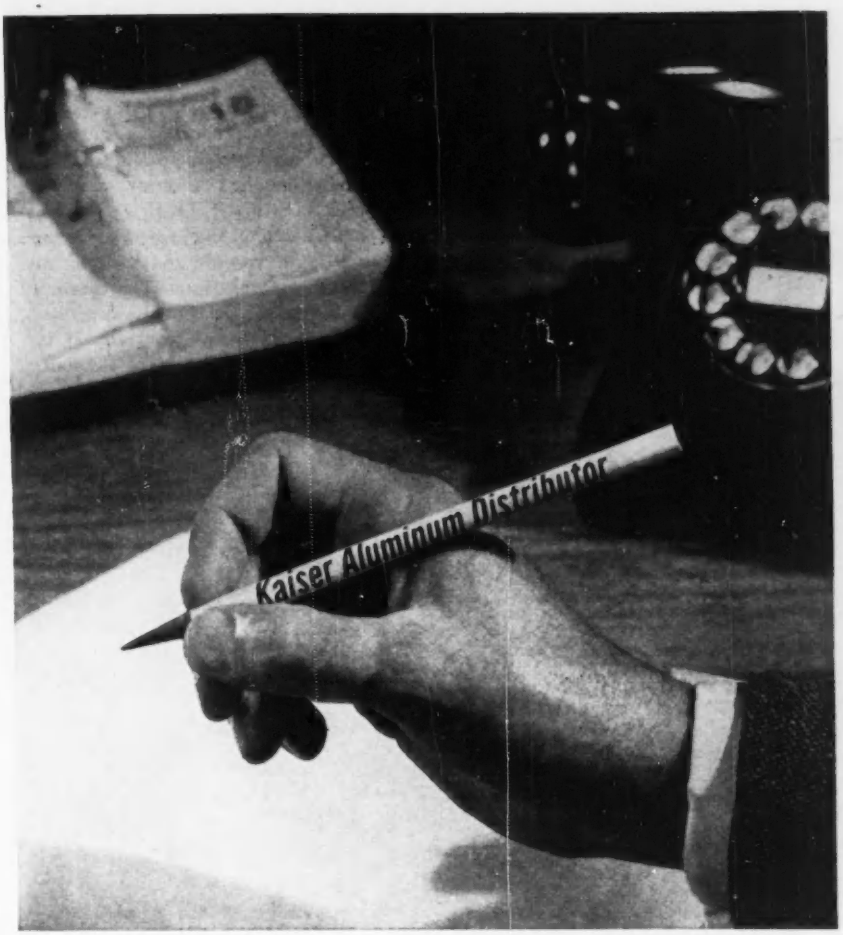


Figure what he means to you

WHEN you add up the many services offered to you by your Kaiser Aluminum Distributor, it's easy to see why he is an important part of your business.

Regardless of market conditions or the size of your order, he gives you interested, personal attention. His specialized knowledge, backed by years of experience, is at your disposal.

He keeps himself—and you—up-to-date on new developments. He closely follows changing government requirements to assist you in obtaining subcontract work.

When you need metal for emergencies, or for experimental work, he helps you obtain supplies.

And he probably will be able to supply you with the aluminum you need. That's because Kaiser Aluminum already has greatly expanded its production to make more aluminum available—and will soon have increased its production capacity 137%!

See your Kaiser Aluminum Distributor *often.*

Your nearest Kaiser Aluminum distributor is listed at the left. Call him TODAY.

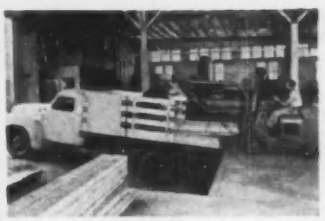
Kaiser Aluminum

Setting the pace . . . in growth, quality and service

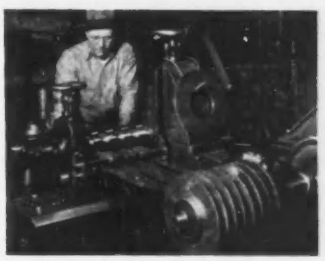
PRODUCERS OF: Sheet • Coil • Plate • Pig • Ingot • Billet • Foil • Electrical Conductor Residential Siding • Corrugated Farm and Industrial Roofing • Shade Screening • Rod, Wire & Bar Screw Machine Stock • Forging Stock • Rivet Wire • Roll-Formed Shapes • Extrusions

HERE'S HOW YOUR DISTRIBUTOR HELPS YOU:

SMALLER SPACE REQUIREMENTS—Small lot purchases mean less space is needed to house raw materials. Result: you can devote more space to profitable production.



LOWER COSTS—Specialization of warehouse plant and handling equipment permits deliveries at lower cost at machine side, cuts stock keeping and accounting costs.



LOWER RAW MATERIAL INVESTMENT—Slit, sheared, or sawed stocks to fit every production demand can be delivered to you daily. Eliminates expense of idle or obsolete inventory.

MORE VERSATILE INVENTORY—Large stocks maintained by your warehouse distributor give you the opportunity to select from a complete range of alloys and forms.

LESSONS IN HYDRAULICS

The Beaver

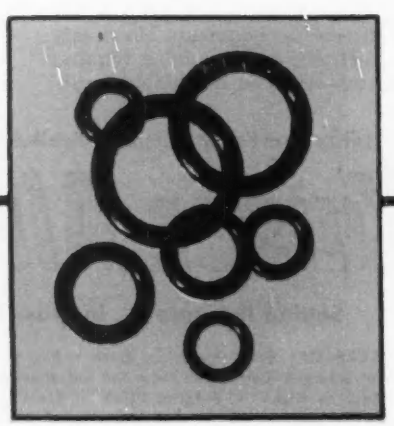
The beaver's building skill captures the imagination of engineers and naturalists alike. This industrious animal is undoubtedly the "woodland's greatest hydraulic engineer" In constructing dams and lodges, he cuts down small trees, dragging them into the water. Stripped of bark, these sticks and poles are shoved endwise into the dam or lodge structure. Stones are pushed or carried to the site and wedged into place, while mud is scooped up from the pond bottom and placed in crevices much like mortar. Beaver dams may be from 30 to 80 feet wide, and usually are strong enough to walk across. Lodges—often 20 feet in diameter—are built of interlocked sticks, stones and mud. *This watertight construction may actually be the forerunner of modern reinforced concrete—another lesson man has learned from nature.*

WOODLAND'S GREATEST HYDRAULIC ENGINEER

Many products have design features requiring a hydraulic seal with special properties in addition to close tolerances and extreme uniformity. If yours is such a product, you'll want to know more about *injection molded* Minnesota O-Rings. Available in numerous compounds of natural or synthetic rubber, Minnesota O-Rings have great tensile strength, extreme capacity for pressure, and high resistance to compression set, abrasion, and oil swelling. Check these examples of successful installations in air, gas, and hydraulic systems: dispensing mechanisms . . . hydraulic rams and valves . . . air cylinders . . . remote control mechanisms . . . spraying equipment . . . gasoline and steam engines . . . and water pumps. Minnesota O-Rings are the choice of industries leading engineers and product designers. For prompt analysis and quotation on your requirements, send us your blue prints or specifications.

INJECTION MOLDED MINNESOTA O-RINGS

Minnesota Rubber's exclusive injection molding process produces O-Rings and other small rubber parts to meet extreme uniformity and tolerance requirements . . . and at low average prices. *Send for bulletin on injection molded Minnesota O-Rings.*



MINNESOTA RUBBER & GASKET CO.

3630 Wooddale Ave. • Minneapolis 16, Minn. • Phone WHittier 6511

AFFILIATED WITH MINNESOTA SILICONE RUBBER CO. • *OFFICES IN PRINCIPAL CITIES*

FOR GREATER SAFETY

Greyhound Specified

VICKERS HYDRAULIC POWER STEERING

on 400 New Coaches

Always searching for ways to further increase passenger safety, Greyhound Lines selected Vickers Hydraulic Power Steering for the 400 new Model PD-4104 GM Coaches recently purchased.

Vickers Hydraulic Power Steering prevents the possible loss of driver control when a vehicle is forced off the pavement onto a soft shoulder . . . or when a front tire blows out. Extra steering power and quick maneuverability are always available for emergency conditions.

The Vickers System absorbs all road shock and transmits it to the vehicle frame . . . there can be no kick-back at the steering wheel. The driver supplies only enough effort to slightly move a servo valve . . . fatigue is thus greatly reduced and the driver is more alert.

Only minor alterations are usually required to incorporate Vickers Hydraulic Power Steering in new and existing vehicle designs. For further information, ask for new Bulletin M-5104.

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

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Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER ROCKFORD • SEATTLE • TULSA • WASHINGTON • WORCESTER

VICKERS *hydraulic*

POWER STEERING

is Effortless
Positive and Shockless

6231

Vickers Hydraulic Power Steering Booster does the actual work of steering

Engine-driven Vickers Vane Pump (with integral volume control and relief valves, and oil reservoir) supplies power for steering.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

THE First
AND STILL THE FINEST BEARING OF ITS KIND

CONCAVEX DESIGN GIVES YOU BEARINGS THAT

Originated by Shafer over 3 decades ago, ConCaVex is still the "years ahead" design in roller type bearings. It has met all challenges—shown all industry what the words "anti-friction-efficiency" really means!

This basically superior ConCaVex design combines in one bearing the distinct structural and operational advantages of both ball and roller type bearings. Installed in your product or your plant equipment Shafer ConCaVex Bearings will improve your ability to produce a quality product more efficiently at less cost. Ask for full information and engineering assistance. No obligation.

ARE COMPACT AND STRONG

HAVE RESERVE CAPACITY FOR SHOCK LOADS

HAVE AUTOMATIC SELF-ALIGNMENT

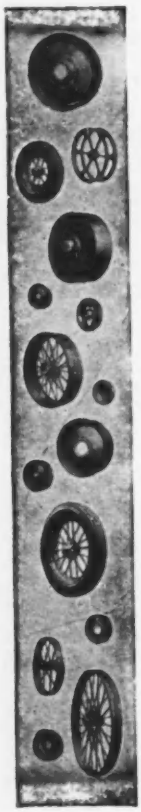
SHAFER BEARING CORPORATION
801 BURLINGTON AVENUE
Downers Grove, Ill.

SHAFER
SELF-ALIGNING
ROLLER BEARINGS
INDUSTRIAL • AIRCRAFT

STAY STRONGER YEARS LONGER

CARRY RADIAL-THRUST LOADS IN ANY COMBINATION

WITHSTAND GREATER THRUST LOADS



FOR FARM AND INDUSTRY
ELECTRIC
WHEELS ARE RIGHT

Over 65 years in wheel manufacturing have given us the "know how"—modern production methods assure long life and efficient wheel performance in the field.

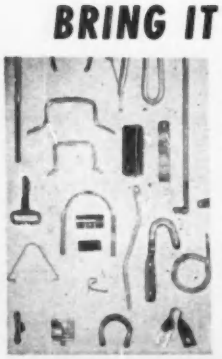
There is an ELECTRIC spoke or disc wheel for most types of portable equipment. Axles are available where required.

Our experienced engineers are ready to assist you in solving your wheel and axle problems and we will offer our recommendations upon receipt of your specifications.

WRITE FOR CATALOG
ELECTRIC WHEEL CO.
2816 CHERRY, QUINCY, ILL.

Stumped By an Unusual Wire Form or Assembly Problem?

BRING IT to CUYAHOGA!

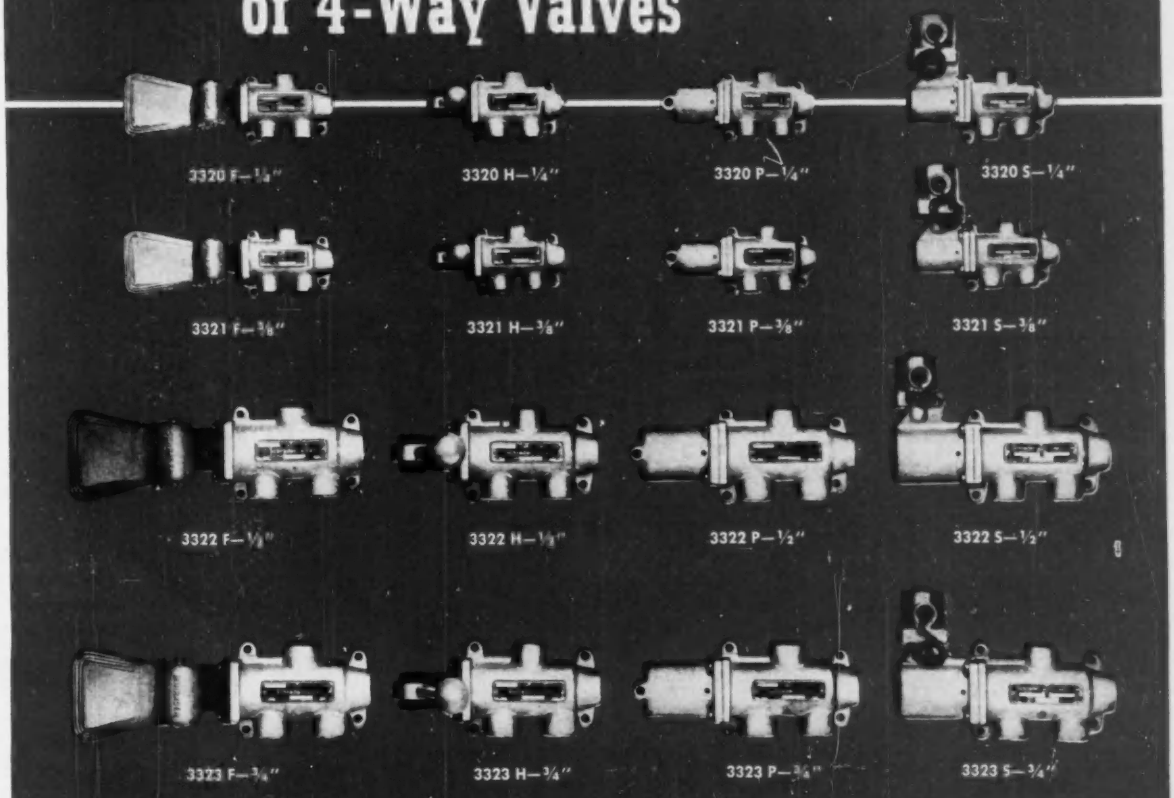


CUYAHOGA'S ENGINEERS and DESIGNERS are turning out new ideas every day for leading manufacturers of aircraft, automobiles, appliances, toys, novelties, etc.

If you have a problem involving the use of flat steel parts, springs, forms, assemblies or stampings, contact your Cuyahoga representative or write direct. Our design service is available at no cost.

The CUYAHOGA SPRING Co.
SUBSIDIARY OF THE BARIUM STEEL CORP.
10254 BEREA ROAD • CLEVELAND 2 OHIO

Schrader presents a complete NEW LINE of 4-Way Valves



FOOT OPERATED
Feature light foot action—can be operated all day without fatigue.

HAND OPERATED
Feature light snap on and off action for fast, accurate control.

PILOT OPERATED
Especially desirable for remote control applications.

SOLENOID OPERATED
Available for 110, 220 or 440 volt AC.

These new Schrader Valves are primarily designed for operation of Double-Acting Cylinders. Their simplified design and construction of long-lasting metals assure reliable, long service with minimum maintenance. Can be serviced without removal from airlines. Available in the popular sizes ¼, ⅜, ½ and ¾ N.P.T., they are produced for flow capacities from 160 to 425 cubic feet of free air per minute at 100 psi inlet pressure. They demonstrate again Schrader's leadership in compressed air equipment. For full details, write—or fill out and mail the coupon below.

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Air Cylinders • Operating Valves • Press & Shear Controls • Air Ejection Sets • Blow Guns • Air Line Couplers • Air Hose & Fittings • Hose Reels • Pressure Regulators & Oilers • Air Strainers • Hydraulic Gauges • Uniflare Tube Fittings

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Division of Scovill Manufacturing Company, Incorporated
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Please send me full details on your new line of 4-Way Valves.

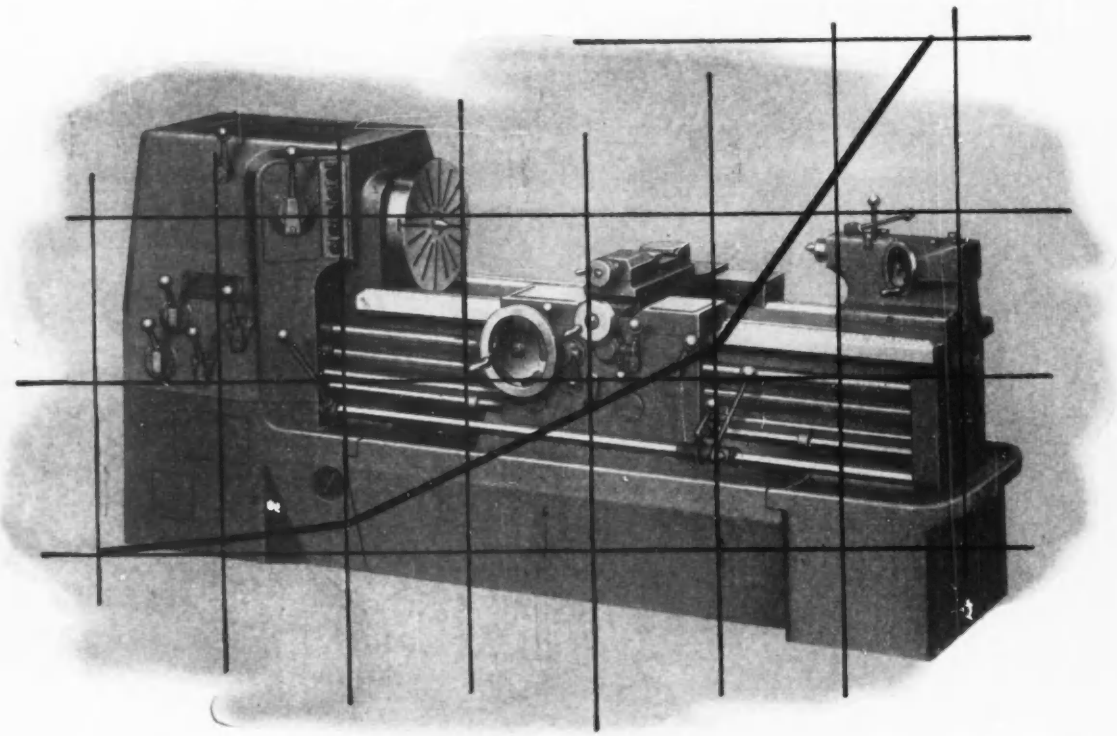
Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

HAVE YOU CHECKED *Your* PRODUCT'S EQ* LATELY?



MAYBE ITS **EFFICIENCY QUOTIENT* NEEDS THE LIFT AETNA ANTI-FRICTION PRODUCTS CAN GIVE

Throughout industry you'll find Aetna precision bearings and parts improving the efficiency and serviceability of today's products and the machines that make them . . . and contributing to the developments of tomorrow.

As a result of Aetna's faculty of solving the sort of anti-friction problems that "couldn't be solved" manufacturers have often realized startling economies or licked tough merchandising problems that stymied sales.

Tell us about YOUR "tough" bearing or parts problems. It's a pretty certain bet that our engineers will be ready with the right answers—at the right prices—for our vast pool of tools and dies, acquired in creating more than 2000 "specials" for industry, usually enables us to meet unique requirements without the expense of new tooling. Just state your problem, send your prints or ask that a nearby representative drop in. No obligation.

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Precision Parts.

AETNA BALL AND ROLLER BEARING COMPANY
4600 Schubert Avenue • Chicago 39, Illinois

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SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

Two Pioneers at Work

...27 YEARS AGO...and TODAY!

BAKER *pioneered*

THE HYDRAULIC CONTROLLED BULLDOZER

Eastman *pioneered*

HYDRAULIC HOSE ASSEMBLIES

"No Push Beam" Hydraulic Controlled Bulldozer

Hydraulic control drops blade 13" below ground; lifts blade 37" above ground level. With hydraulic control set to "hold"—blade tilting, dropping, lifting are automatically corrected to maintain uniform level of cut.

Eastman 1" hydraulic hose and coupling assemblies deliver 900 psi to double acting cylinders; provide positive blade action and more powerful bite.

When The Baker Mfg. Co., Springfield, Illinois, pioneered the first completely hydraulic controlled bulldozer in 1926, they turned to the Eastman Mfg. Co., of Manitowoc, Wis., who was pioneering in the field of hydraulic hose assemblies *at the same time!*

Then, as now—all through these years—Baker bulldozers have been equipped with Eastman Hydraulic Hose Assemblies *exclusively,* giving service in accord with the high standards that have made both Baker and Eastman leaders in their respective fields.

The enviable reputation of Baker "Dozers" is based upon their advanced engineering, plus their durability, versatility and *maneuverability.* A recent addition to their dozer line is the revolutionary "No Push Beam" design which provides unequaled maneuverability and floatation through a combination of unique mechanical linkage and hydraulic suspension.

Positive, dependable power is delivered to these controls through Eastman wire braided hydraulic hose, ranging from ¼" to 2" . . . carrying pressures up to 900 lbs. psi. Leakproof hydraulic couplings form the vital connecting links . . . another example of Eastman's leading role in *"Safeguarding Industry's Lifelines of Mobile Power."* Look to Eastman for leadership in this field.

specify **Eastman** *first in the field*

HYDRAULIC HOSE ASSEMBLIES

for the best performance, for long life and satisfaction—*all along the line*—from manufacturer to user. Check your needs on the following list:

COUPLINGS

Solid Male

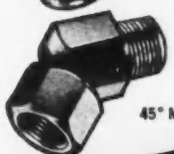
Swivel Male

Swivel Female

STRAIGHT AND ANGLED ADAPTER UNIONS

Straight Male

90° Male



45° Male

Write for free catalog 102 on Eastman Hose Couplings and Bulletins 2318 & 2328 on Straight and Angled Adapter Unions.

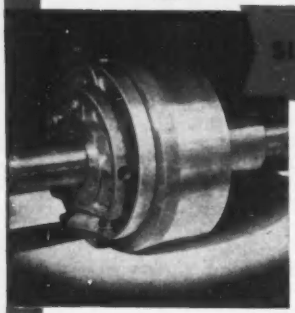
Eastman

MANUFACTURING COMPANY

Since 1914

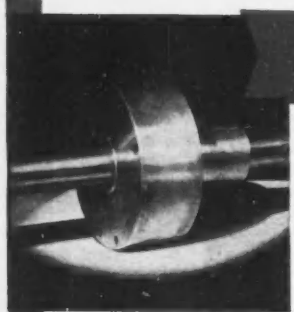
Dept. PE6, Manitowoc, Wisconsin

HILLIARD *Clutches* FOR POWER CONTROL DESIGNS



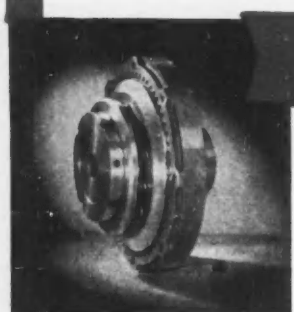
HILLIARD SINGLE REVOLUTION CLUTCH

Unequaled for accurate control of intermittent machine operations—cutting, punching and packaging. Gives closer tolerances to cut-off, stamping, shearing and similar machines. Completely automatic; manual, mechanical or electrical control.



HILLIARD OVER-RUNNING CLUTCH

Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unsurpassed for automatic two-speed drives, dual drives, stand-by drives and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.



HILLIARD SLIP CLUTCH

A reliable series of spring-loaded slip clutches and couplings. Rugged construction with ample friction surface for heavy-duty use. Outstanding for preventing overloads and shocks; for starting heavy loads; as tension drag brakes; for reeling and winding operations and many other uses.

★ HILLIARD CLUTCHES and COUPLINGS make machine drive and power transmission more efficient and economical. Experienced engineers will be glad to offer their advice on any problems. Complete descriptive material will be furnished on request.

WRITE TODAY for our illustrated brochure #MP-4 for information.

CLUTCH MAKERS FOR OVER FORTY-FIVE YEARS

THE HILLIARD *Corporation*

101 W. FOURTH STREET, ELMIRA, N. Y.

In Canada • • • UPTON - BRADEEN - JAMES, LTD.

MEYERCORD *Nameplate* DECALS *Laboratory Engineered* FOR EVERY SURFACE AND FINISH

Meyercord Decal Engineers and Designers Can Help You Lick that Tough Problem . . . and at LOWER COST, TOO!

If you want to ADVERTISE . . . INSTRUCT . . . or IDENTIFY on any surface from smooth, non-porous plastics to rough, pebbly materials, Meyercord engineers will come up with the answer in a hurry. We dipped into our recent orders and highlight below a few "case histories" where Meyercord Decals have been engineered for extremely difficult conditions:

AIRCRAFT INDUSTRY

Meyercord engineers, working closely with industry engineering departments, developed a special indentification decal capable of withstanding Jet temperatures to 900° as well as the effects of aeromatic fuels and hydraulic fluids.

PLASTICS INDUSTRY

A Kansas City plastics manufacturer wanted a series of decals showing miniature gasoline pumps for application to plastic salt and pepper shakers. Meyercord produced a special transfer that meets the customer's requirements.

ELECTRONICS INDUSTRY

A leading electronics manufacturer required a schematic diagram which could be folded compactly and placed inside communication sets. Meyercord solved the problem with a special decal applied to nylon fabric.

HOME APPLIANCES

To reduce manufacturing costs without sacrificing quality, Meyercord engineers developed a new type of open-letter decal providing high color and dramatic effect—at less than one third the cost of discarded metal name plates.

Write for MEYERCORD DECAL NAMEPLATE MANUAL and Full Information . . . FREE

Meyercord "Mark-it" Manual shows hundreds of uses for durable, washable, decal nameplates . . . as trade marks, instructions, charts or diagrams . . . in any size, colors or designs. Shows how Meyercord Decal Nameplates speed production, cut costs. This manual is FREE . . . but request it on company letterhead, please.

THE MEYERCORD CO.

World's Largest Decalcomania Manufacturers

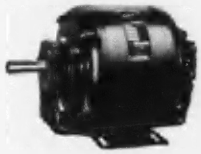
DEPT. F-318, 5323 WEST LAKE STREET • CHICAGO 44, ILLINOIS

extra value for your products . . .

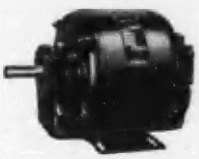
PACKARD ELECTRIC MOTORS

for:

BENCH TOOLS • BLOWERS • COMPRESSORS • DRYERS



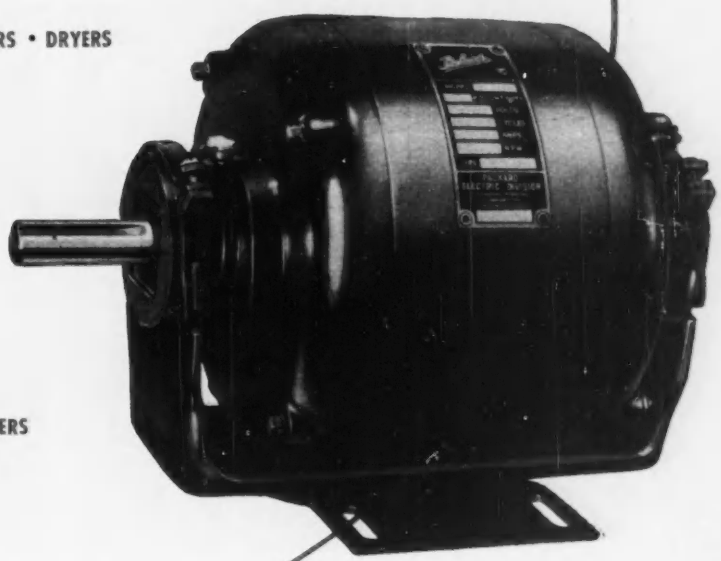
DISPOSAL UNITS • WASHERS • IRONERS



OIL BURNERS • STOKERS • LAWN MOWERS

WATER PUMPS • MILKING MACHINES

CREAM SEPARATORS • VENTILATING UNITS



When your product is powered with a Packard Electric motor, its performance and reliability make it a salesman that never stops selling for you.

Packard Electric's tremendous facilities for volume production make it possible for you to put these "silent salesmen" to work for your motor-powered products at a surprisingly low cost. Why not get all the facts now, from Packard engineers?

DEPENDABLE APPLIANCE MOTORS FOR THIRTY-SIX YEARS

GM GENERAL MOTORS

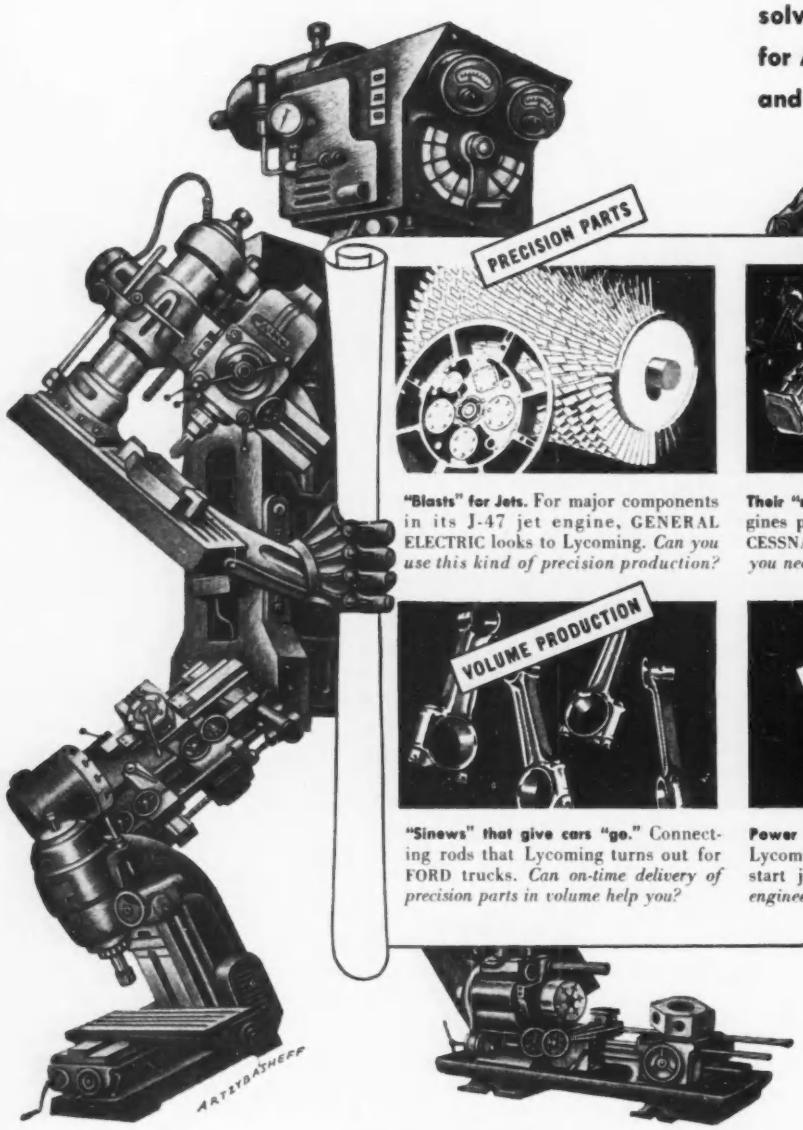
Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division
General Motors Corporation
Warren, Ohio

Big "doings" in metal

Here are just four outstanding achievements of Lycoming's precision production : . . samples that indicate how Lycoming solves metal-working problems for America's industrial leaders and the Armed Forces.



"Blasts" for Jets. For major components in its J-47 jet engine, GENERAL ELECTRIC looks to Lycoming. *Can you use this kind of precision production?*

Their "song" fills the air. Lycoming engines power aircraft made by BEECH, CESSNA, PIPER, AERO-COMMANDER. *Do you need this kind of dependable power?*

"Sinews" that give cars "go." Connecting rods that Lycoming turns out for FORD trucks. *Can on-time delivery of precision parts in volume help you?*

Power generator for jets. Created by Lycoming for the U. S. AIR FORCE to start jets and bombers. *Can creative engineering help solve your problem?*

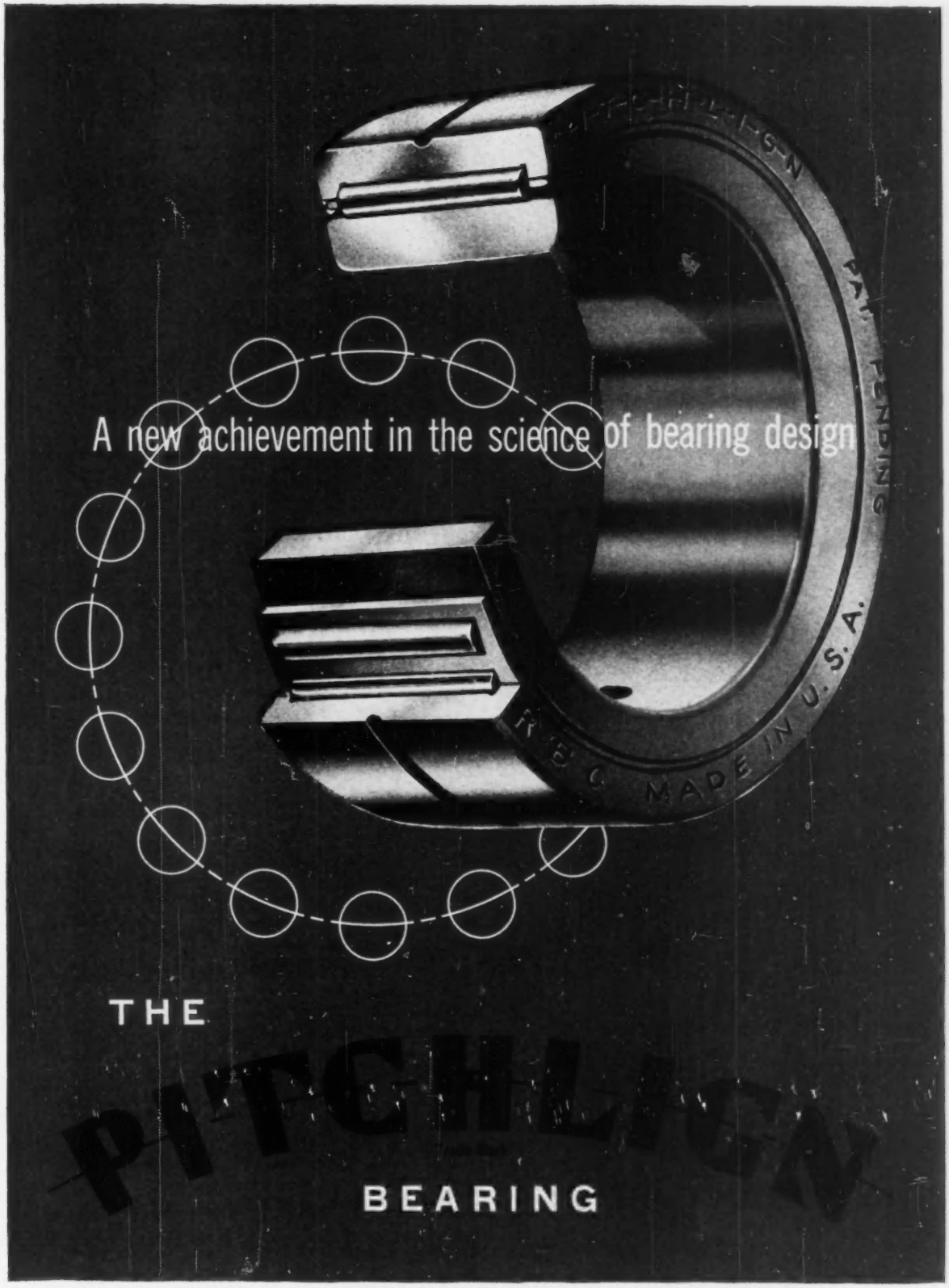
Even these few samples demonstrate that Lycoming has the machines you can use—the skilled craftsmen you can use . . . the immense facilities you can use . . . the creative thinking you can use! For a more complete story on Lycoming, write for the illustrated booklet, "Let's look at Lycoming."

FOR RESEARCH · FOR PRECISION PRODUCTION

LOOK TO LYCOMING

Lycoming-Spencer Division, Williamsport, Pa. AVCO Manufacturing Corporation Bridgeport-Lycoming Division, Stratford, Conn.

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION



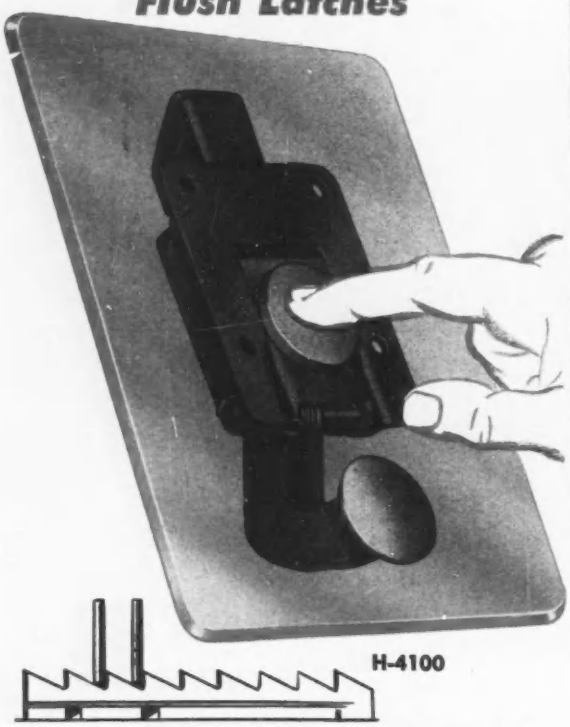
Write for Bulletin SF-669

Roller Bearing Company of America, Sullivan Way, West Trenton, New Jersey

HARTWELL

sets a new pattern for the future with

Push Button Flush Latches



Improve LATCHING Performance! Go Modern with HARTWELL Flush—Self-Closing—Easy to Operate—Simple to Install

Latch is operated by a natural rotation of the hand for push-and-lift positive action. As the forward button is depressed, the rear button raises, providing a sturdy grip for opening the door.

Your need for efficiency and economy today finds a powerful ally in the *Flush Latch* and *Hinge* talents of HARTWELL. Here is the latest *"push button"* method for solving your *flush* latching problems.

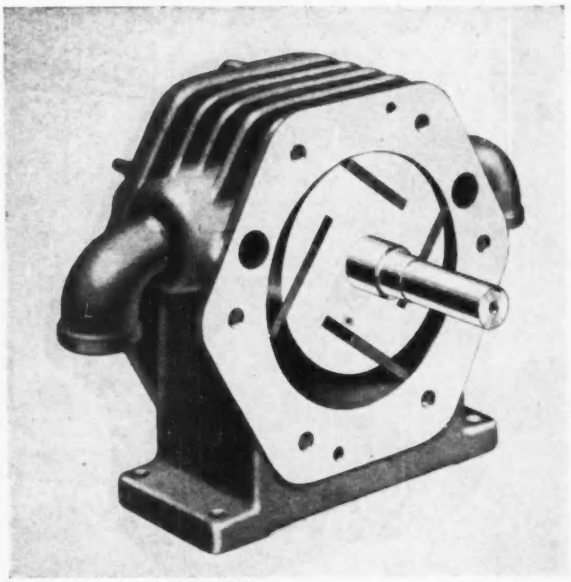
Write for engineering specifications and counsel.

HARTWELL COMPANY

Manufacturer of Flush Latches and Hinges, Fittings and Cable Terminals.

9035 Venice Boulevard, Los Angeles 34, California

The Dexter-Conde DRI-AIR Pump providing vacuum to 20 inches . . . oil-free pressure to 12 p. s. i. *needs no lubrication!*



The Dexter-Conde DRI-AIR Pump

This pump delivers clean air, free from oil spray or mist. Its wide use by manufacturers of printing and packaging machinery* where even the slightest trace of oil could spoil the product, proves that here is a completely dependable vacuum and pressure pump.

Consider these DRI-AIR features:

- Carbon-graphite vanes — stick-proof, warp-proof, chemically inert — provide their own lubrication
- Double-sealed, grease-packed New Departure ball bearings, completely removed from pump chamber
- No oil cups to be tended — or expensively overlooked
- No greasy dirt accumulations or oil pool fire hazard
- High efficiency increases as pump is used
- Runs cool — with negligible wear and long life
- No gaskets to leak or blow
- Performance unaffected by normal temperature changes

Available in capacities of 6.2, 17.0 and 35.0 c. f. m.

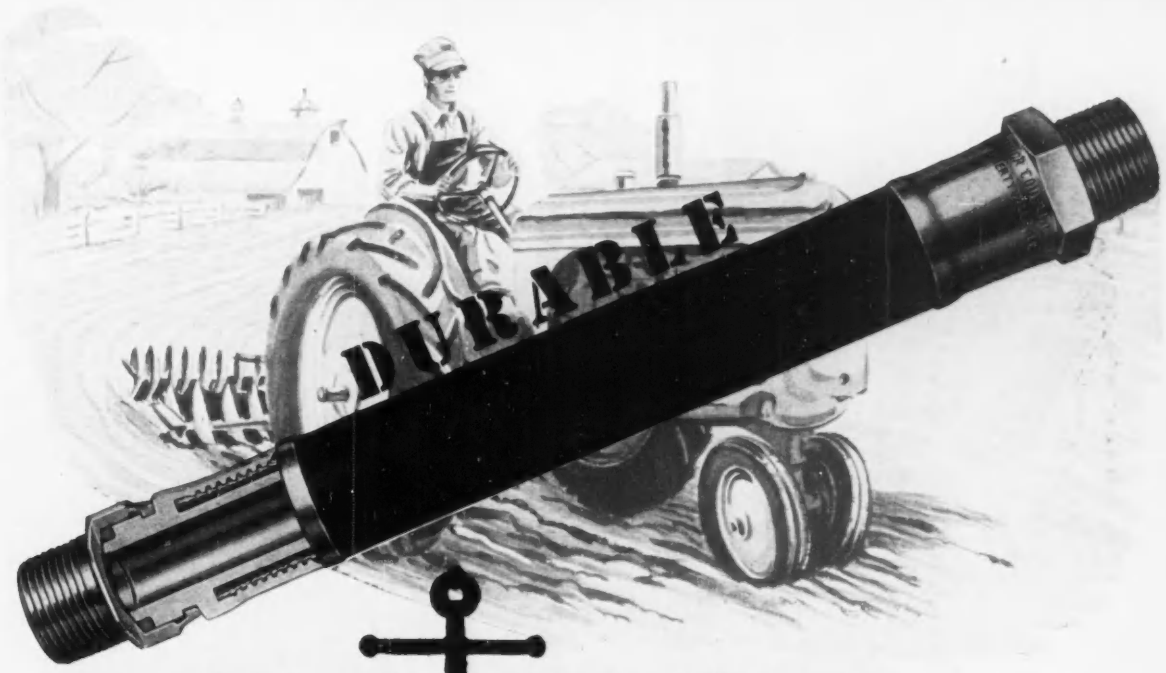
Vacuum — 27.8" maximum, intermittent operation
15" to 20" steady operation

Pressure — up to 12 p. s. i.

**Including Dexter feeding, folding and binding machines*

The Dexter-Conde DRI-AIR Pump has been given a complete series of tests by the U. S. Testing Company, Hoboken, New Jersey. A copy of their report, together with further technical information, will be sent on request made to:

Dexter Folder Company
General Sales Offices
330 West 42nd Street, New York 36, N. Y.



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ONE-WIRE BRAID HOSE ASSEMBLIES

for medium-and low-pressure service

Factory-assembled to your specifications—you get just what you need.

Long, uniform, positive grip assured by internally-threaded coupling shell.

Eliminates leaks and blow-offs in medium- and low-pressure service.

Sizes and types for every application — available with solid male or union male ends.

"O" ring seals prevent leakage between swivel ends and the coupling body.

Use of swivel male ends eliminates need for adapter unions, reduces the number of joints, and lets hose assume normal position when pressure is applied to the line.

Exclusive Anchor Max-Flo coupling gives you the equivalent of unrestricted flow through the couplings.

• • •

Get more information. Attach coupon to your letterhead and mail today!

NEW!
REVOLUTIONARY
ANCHOR FLANCO
SPLIT-FLANGE CLAMP
Positive leakproof connection without threaded joints. Bolt centers are located to distribute the forces evenly and prevent tilting of the clamp halves. Easy to assemble with small automotive-type wrench.

ANCHOR COUPLING CO. INC.

Main Office and Factory: LIBERTYVILLE, ILLINOIS

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Anchor Coupling Co. Inc.
Dept. PE63, Libertyville, Illinois
Yes, I'm interested in
☐ Anchor one-wire braid hose assemblies
☐ New Anchor Flanco Split-flange clamp-type coupling
Send me information.

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take your pick!

Scaife Pressure Vessels will meet your specifications

Consider Scaife Company Water Heater Tanks for example. They're built to every customer's exact specifications . . . making use of Scaife Company's advanced production techniques that ensure dependability, uniformity and economy in every unit produced.

Through continuous research, rigid quality control and over 150 years of manufacturing experience, Scaife Company is well fitted to develop top-flight pressure vessels in the quantities needed to supply your production line.

Whether you require water heater tanks, ASME, or other code or non-code pressure vessels, you'll find Scaife Engineering skill and ingenuity can provide the answers to your problems.

TYPICAL USES FOR SCAIFE PRESSURE VESSELS

- Tanks for Air Compressors
- Tanks for Railroad Cars
- Tanks for Water Heaters
- Diesel Engine Starting Tanks
- Tanks for Pneumatic Control Systems
- Hydro-Pneumatic Tanks for Well Pump Systems
- Domestic Water Purification Tanks
- Gas Cylinders and Tanks (ICC and ASME)
- Tanks for the Plumbing Industry

May we send you more detailed information on Scaife pressure vessels? Write: Sales Department, Scaife Company, 26 Ann Street, Oakmont (Pittsburgh District), Pennsylvania.

FOUNDED 1902

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OAKMONT (PITTSBURGH DISTRICT) PENNA.

MAKERS OF PRESSURE VESSELS AND DRAWN SHAPES

IBM

TRADE MARK

has several excellent opportunities on its engineering staffs at Endicott and Poughkeepsie, N. Y. Salaries open.

Electronic and mechanical engineers and draftsmen experienced in circuit design or intricate mechanism design for product development are cordially invited to submit résumés of their education and background. Replies will be held in strict confidence.

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All FORMSPRAG CLUTCHES ARE *Full Complement* CLUTCHES

WHAT IT MEANS:

A full complement of sprags is inserted in the annular space between an inner and outer race. Contact with race surfaces is maintained by energizing springs.

WHY IT'S IMPORTANT:

The energized sprags grip at an infinite number of positions. When torque is applied, the sprags *instantaneously* engage . . . when torque is removed, they *instantaneously* release. Positive, accurate engagement and disengagement may be made hundreds of times per minute—with no backlash.

Formsprag Full Complement Clutches always provide MAXIMUM TORQUE CAPACITY (for size and weight) . . . and LONG LIFE because of low unit stresses at changing contact points.

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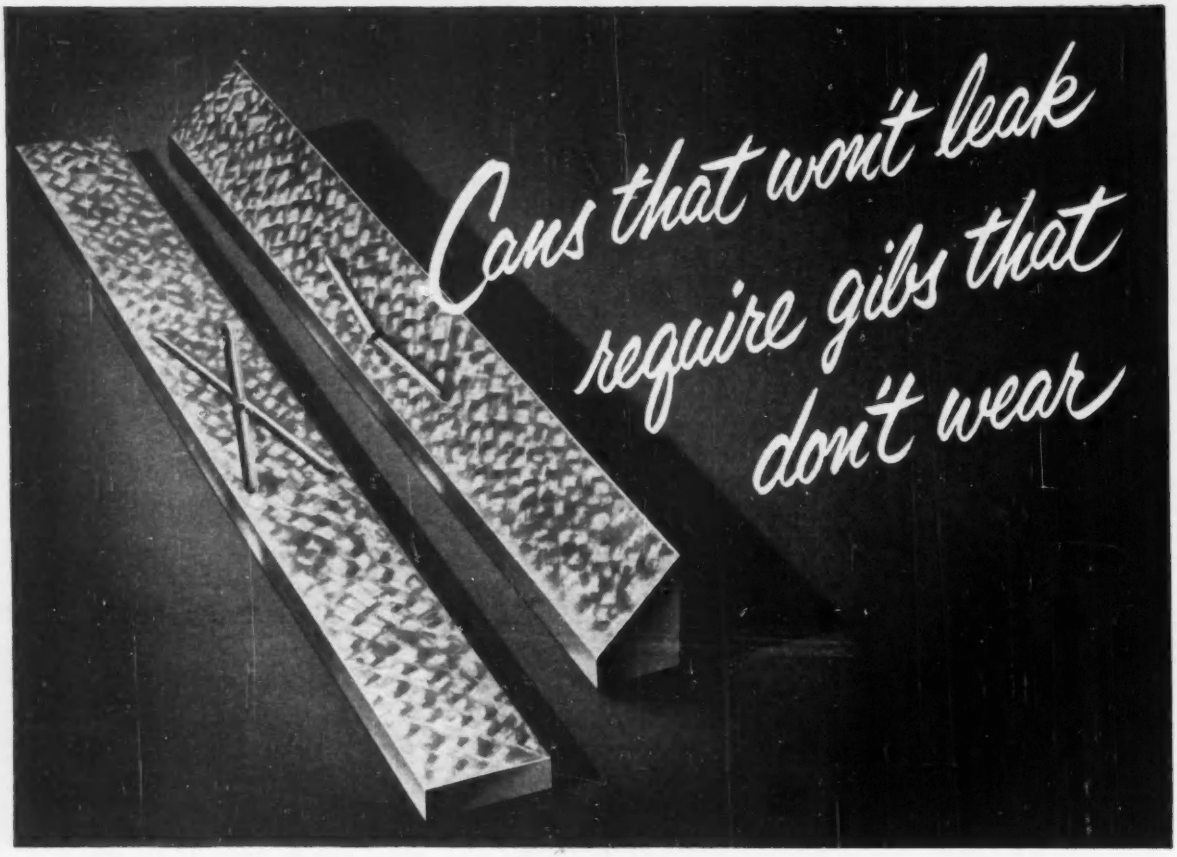

THEY'RE MADE OF BERYLCO BERYLLIUM COPPER

When you discard a tin can, you may not think you're throwing away a precision device, but you are. All parts of a can must be accurately formed to within one ten-thousandth inch, otherwise leakage and spoilage will result.

The flat and bevel gibs shown here are used on a bodymaker producing 12 and 6 oz. spray cans. Twenty-six dies, each guided by similar Berylco gibs, turn out 100 can bodies per minute. Tolerances are so critical that gib wear of less than .001" can cause trouble. Production stoppages pile up headaches, and thousands of cans can be ruined through corrosion.

Gibs machined from Berylco #25 bar stock have now been employed for the "SPRA-TAINER" bodymaker twice as long as any previously used material, and there have been no shutdowns. The superior wear resistance of Berylco is due not so much to its heat-treatable feature—work-hardening alone is sufficient—as to its dense, less porous structure, which reduces friction and makes lubrication less critical.*

Wear resistance is only one of the many desirable engineering qualities of Berylco beryllium copper. Its unique combination of such properties as strength, conductivity, elasticity and fatigue resistance has enabled designers to convert difficult or "impossible" jobs into standard production items.

As the world's largest producers, we will be glad to help you include beryllium copper in your plans for the future. For sample material or engineering assistance, call or write any of the offices below.

VALUABLE ENGINEERING INFORMATION

on Berylco beryllium copper is contained in a series of technical bulletins, published monthly. To receive your copy regularly, write on your business letterhead.

TOMORROW'S PRODUCTS ARE PLANNED TODAY—WITH BERYLCO BERYLLIUM COPPER

*Data supplied by Crown Can Co. (Div. C. C. & S. Co.), Phila., Pa.

BERYLCO THE BERYLLIUM CORPORATION

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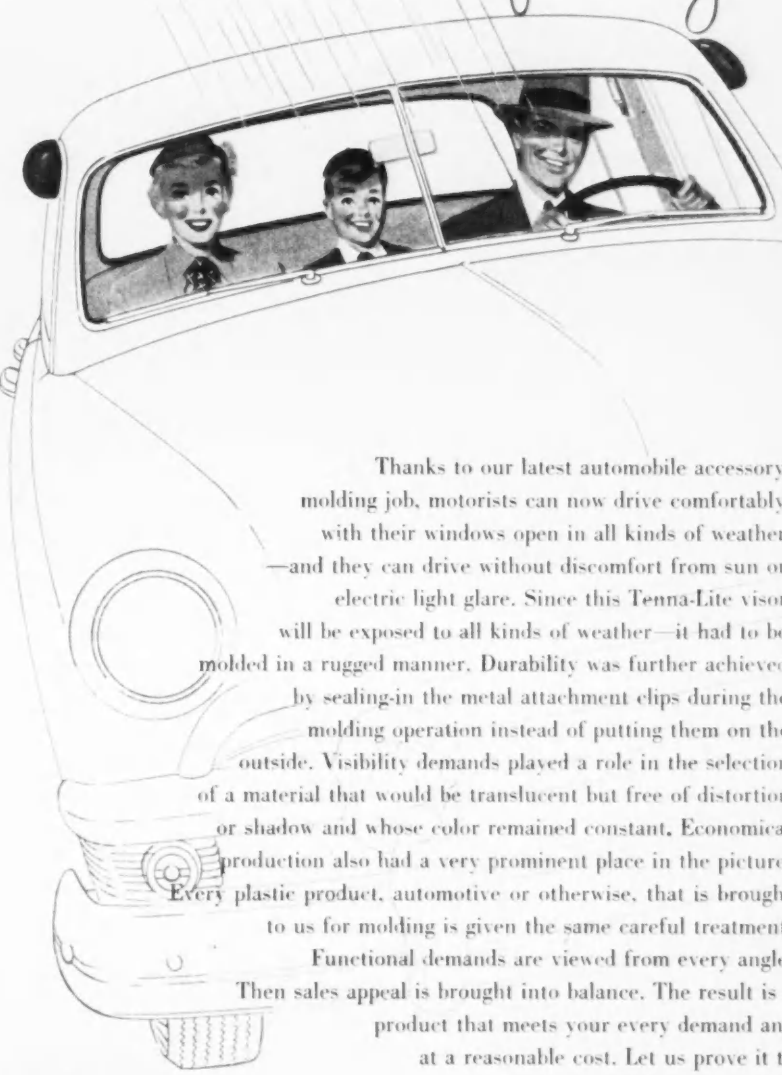
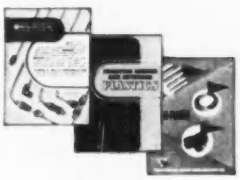
Comfortable Driving is a Matter of Molding



Thanks to our latest automobile accessory molding job, motorists can now drive comfortably with their windows open in all kinds of weather—and they can drive without discomfort from sun or electric light glare. Since this Tenna-Lite visor will be exposed to all kinds of weather—it had to be molded in a rugged manner. Durability was further achieved by sealing-in the metal attachment clips during the molding operation instead of putting them on the outside. Visibility demands played a role in the selection of a material that would be translucent but free of distortion or shadow and whose color remained constant. Economical production also had a very prominent place in the picture. Every plastic product, automotive or otherwise, that is brought to us for molding is given the same careful treatment. Functional demands are viewed from every angle. Then sales appeal is brought into balance. The result is a product that meets your every demand and at a reasonable cost. Let us prove it to you today without obligation.



Write on your letterhead for new Injection Molded and Extruded Plastics Catalog. Or, for detailed information about [redacted], piping, tubing and fittings, write for circulars containing data and illustrations. *Trademark Registered*

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INJECTION MOLDERS and EXTRUDERS of: Tenite, Lumarith, Plastacele, Fibestos, Lucite, Nylon, Plexiglas, Polystyrene, Styron, Loalin, Vinylite, Geon, Plexene, Polyethylene, Cerex, Forticel, [redacted]*, Saran, and other Thermoplastic Materials.

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Tenna-Lite Plastic Door Visor, molded for Tenna-Lite Corp., Chicago

GLOBE

specialization gives you "Tops in Quality"

ALLOY STEEL TUBES

SEAMLESS — MECHANICAL — PRESSURE — CORROSION RESISTANT

TYPICAL ANALYSES:

Carbon	5 Chrome ½ Moly
Carbon ½ Moly	7 Chrome ½ Moly
½ Chrome ½ Moly	8 Chrome ½ Moly
1 Chrome ½ Moly	8 Chrome 1 Moly
1¼ Chrome ½ Moly	9 Chrome 1 Moly
2 Chrome ½ Moly	3% Nickel 7% Nickel
2¼ Chrome 1 Moly	5% Nickel 9% Nickel

AISI Types: 304-321-347-316-309-310-405-410-430-443-446

Analyses to meet conditions where heat, corrosion, pressure and structural strength are involved.

SIZE RANGE — WALL THICKNESS:

½ to 6 inches O.D. — wall thickness .035 to 1.000 inch.

TYPICAL APPLICATIONS:

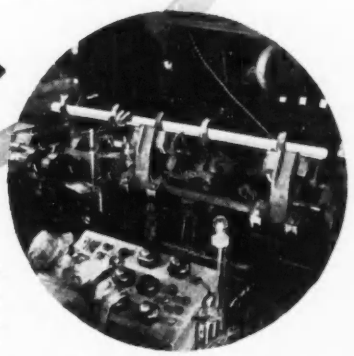
Pressure tubes — Superheater tubes — Condenser tubes — Still tubes — Evaporator tubes — Barrel tubes — Oil-well Pump Barrels — Mechanical tubes — Aircraft tubes — Propeller tubes — Rollers for Transmission Chains.

Globe engineers gladly give you the benefit of specialized knowledge of stainless steel tubing in a wide range of services and applications — to improve your product — to cut costs.

TO BE SURE . . . SPECIFY GLOBE

GLOBE TUBES

The heating, piercing, rolling of seamless tubes is controlled at every step for uniformity, close tolerance.



WHEN you specify Globe, you get uniform high quality alloy steel tubes, the product of highly developed production facilities and specialized quality controls and methods. All Globe tubes are thoroughly inspected and closely held within tolerance specifications. Write for the Globe general catalog.

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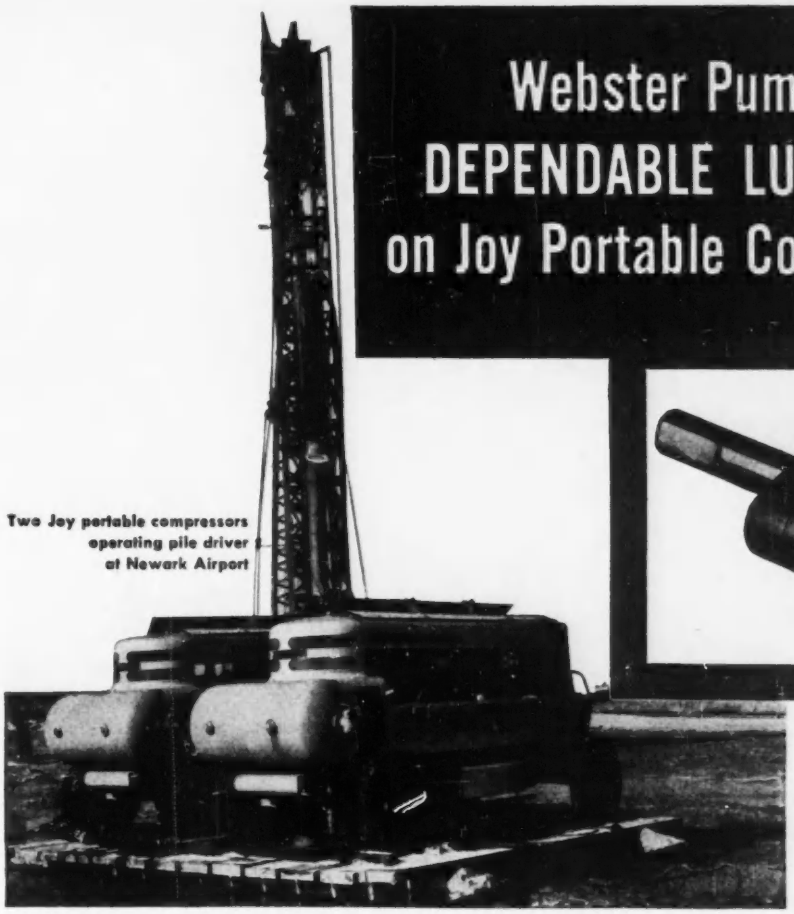
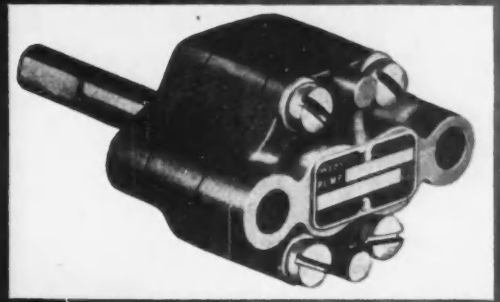
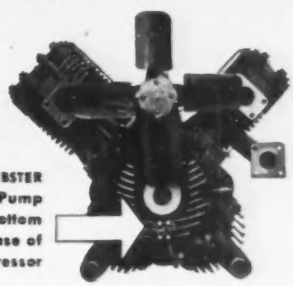
Producers of Globe seamless stainless steel tubes — Gloweld stainless steel tubes — alloy — carbon — seamless steel tubes — Globeiron (high purity ingot iron) seamless tubes — Globe Welding Fittings.

Webster Pumps give DEPENDABLE LUBRICATION on Joy Portable Compressors...



Two Joy portable compressors operating pile driver at Newark Airport





WEBSTER Pump mounted at bottom of crankcase of Joy Portable Compressor

• The exceptionally heavy work demanded of the Joy Manufacturing Company's portable compressors shown above requires a reliable and unfailing system of force-feed lubrication. This is provided by positive-displacement WEBSTER Gear-type Oil Hydraulic Pumps. The pump is face-mounted and gear-driven from the crankshaft.

Behind every WEBSTER Hydraulic Pump is the skill gained during nearly a quarter-century of experience. Their dependable, efficient performance has stood the test of time under widely varying operating conditions. WEBSTER Hydraulic Pumps—available in a *full line* from 10 gph. to 10 gpm. at pressures up to 1200 psi. at speeds of 3600 rpm. or less—lend themselves to many forms of application, and *to modification to special installations.*

Do *you* require pumps for lubrication, oil circulating, transfer, filtering or oil hydraulic power application? Chances are that one of our present 90 models will fill your need; if necessary, we can make one that will! Finding out the facts involves no obligation; just fill in and mail the coupon today.

Oil Hydraulics Division, Webster Electric Company
Dept. PE-6, Racine, Wisconsin

Send me information on WEBSTER Hydraulic Pumps as checked:

Capacity (Approx.)_____G.P.M.
Pressure (Approx.)_____P.S.I.
Pump Speed_____R.P.M.

Name and Title_____
Firm Name_____
Street Address_____
City_____ Zone_____ State_____

OIL HYDRAULICS DIVISION

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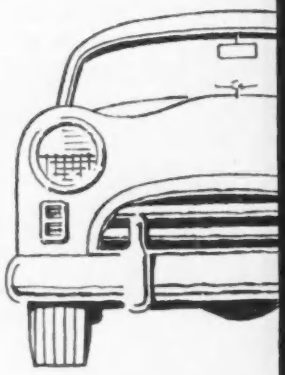
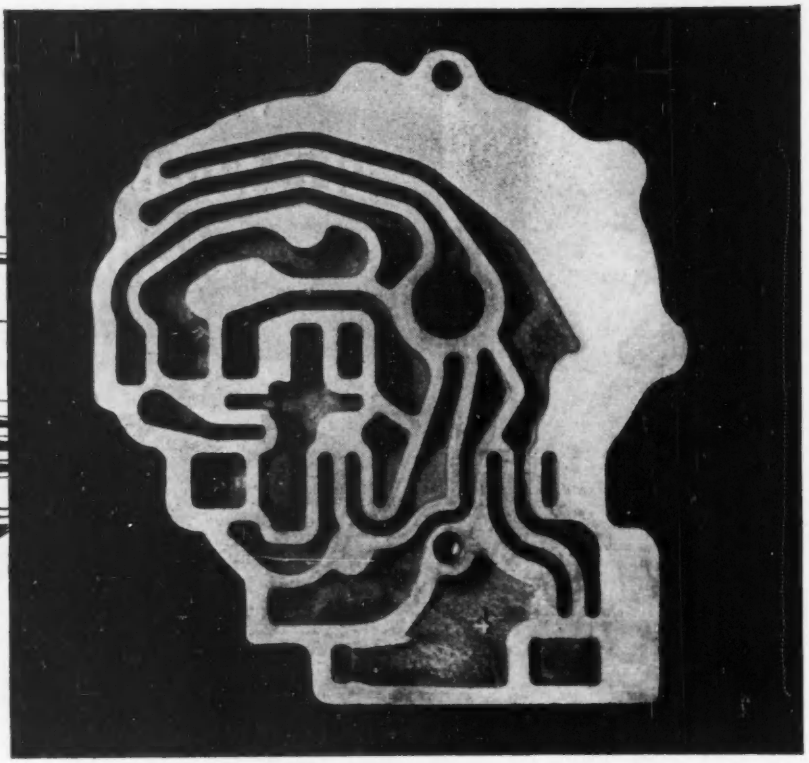
RACINE WISCONSIN

"Where Quality is a Responsibility and Fair Dealing an Obligation"

WEBSTER ELECTRIC COMPANY, RACINE, WISCONSIN • EST. 1909





This intricate maze of metal is the valve section of a popular automatic transmission, cast in Gray Iron.

6 Reasons why the final choice was GRAY IRON!

1. Greater rigidity, strength and dimensional stability
2. Greater accuracy—can be held to closer tolerances
3. Greater wear resistance
4. Does not permit dirt to imbed, as do the softer nonferrous materials
5. Desirable thermal expansion characteristics
6. Economy

Intricate components such as the section shown here are economically practical only as integral castings. The final question then becomes—in what material shall they be cast?

This valve section was first experimentally cast in a nonferrous material. However, the final choice was Gray Iron, for the practical reasons listed at the left. These same basic advantages of Gray Iron could well apply to one of *your* current design problems.

Write for technical information on the many advantages of the Gray Iron casting process.

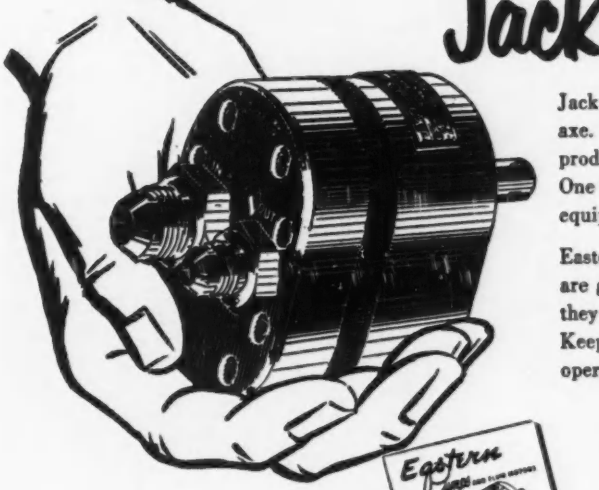
Make it Better with Gray Iron
Second largest industry in the metal-working field

GRAY IRON FOUNDERS' SOCIETY, INC.
NATIONAL CITY-E. 6th BLDG. CLEVELAND 14, OHIO

Jack the Giant Killer

Jack found the best way to slay the giant was with a sharp axe. The solution to industry's giant problem — cutting production costs — involves using a great many axes. One way to help conquer *this* giant is to substitute small equipment capable of doing a big job.

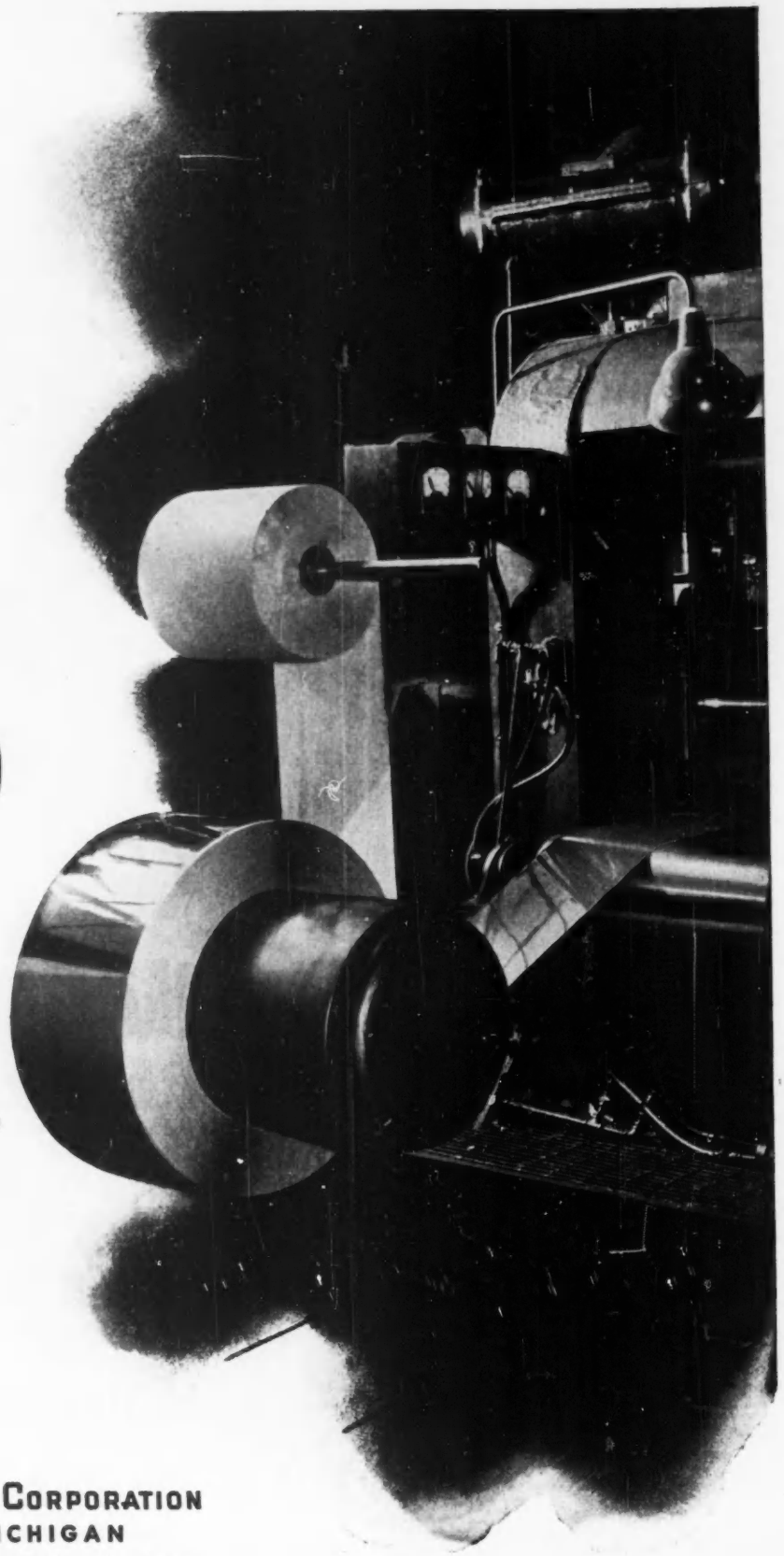
Eastern HYDRAULIC PUMPS and FLUID MOTORS are giant killers in their own right. In many installations they replace more expensive units many times as bulky. Keeping size and weight to a minimum, they help cut operating costs wherever they are applied.



EASTERN INDUSTRIES, INC.

296 ELM STREET • NEW HAVEN 6, CONN.

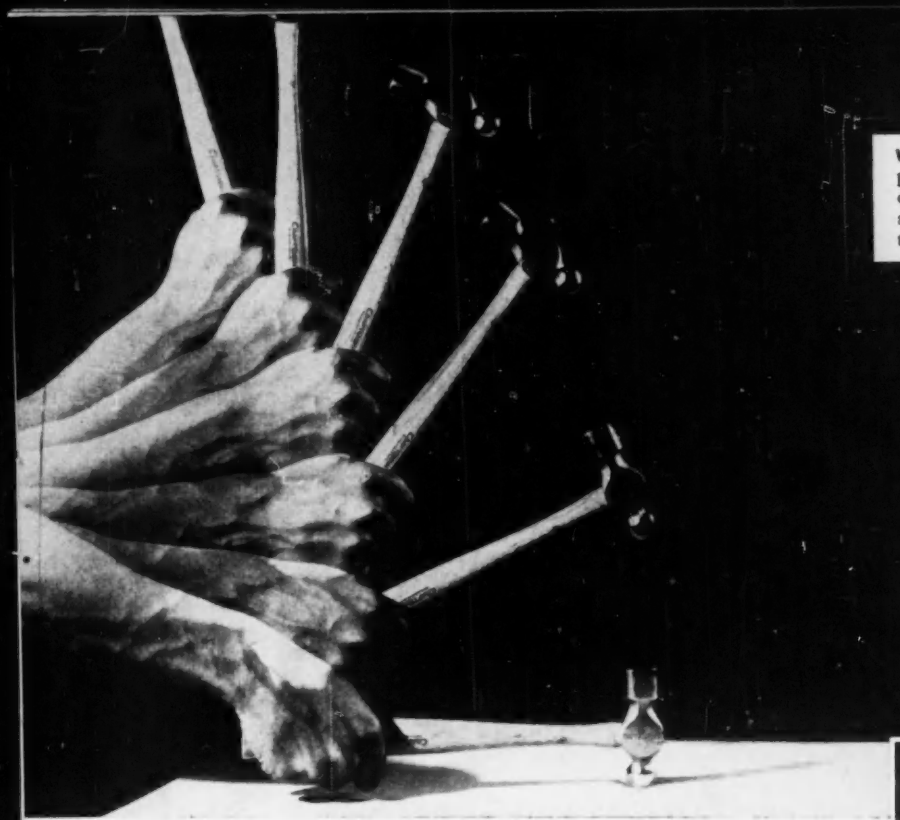
• *To see if one of these units might be your "hen that lays the golden eggs", write for Eastern Bulletin E-800 today.*



McLouth STAINLESS Steel

For the product you make today and the product you plan for tomorrow.

McLouth Steel Corporation
DETROIT, MICHIGAN
Manufacturers of Stainless and Carbon Steels



WON'T SHATTER OR CHIP: Stroboscopic photo shows that repeated hammer blows dent metal but the unusual flexibility and adhesion qualities of NUBELON-S protect the finish from harm.

ENTIRELY NEW BAKING ENAMEL!

NUBELON-S

TOUGHEST — MOST FLEXIBLE EVER DEVELOPED

Now—for the first time—here is a finish that is much harder than any known organic film . . . yet is so flexible and adheres so well it can be bent and twisted without cracking.

More than five years in the making, NUBELON-S combines unique properties which make it ideal for use on home appliances, metal furniture, prefabricated farm silos, fencing wire, and many other applications.

NUBELON-S is available in whites, greys, yellows, blue, tan, green and red. It bakes at 425°F. for 30 minutes.

This new coating is already in use by a number of manufacturers and is being tested by many others. There may be countless applications not yet explored for this extraordinary new enamel. It you have a potential end use which warrants development, we will welcome your inquiry.

Write today for a descriptive folder giving complete NUBELON-S specifications.

THE GLIDDEN COMPANY
INDUSTRIAL FINISHES DIVISION
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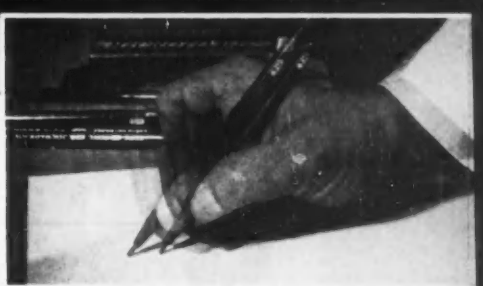
SALES OFFICES AND FACTORIES: San Francisco, Los Angeles, Chicago (Nubian Division—1855 North Leclaire Ave.), Minneapolis, New Orleans, St. Louis, Cleveland, Reading, Atlanta and Toronto.



HIGH HARDNESS: Pencil hardness test shows the NUBELON-S film is 50 per cent harder. It withstands a 7-H pencil as compared with a 2-H for generally used appliance finishes.

EXTREME FLEXIBILITY: NUBELON-S on wire is spiraled around a pencil to demonstrate the flexing it can take without cracking or flaking.

EXCELLENT STAIN RESISTANCE: All typical household stains, many of which cause permanent damage to ordinary organic finishes, wipe off NUBELON-S easily without leaving a trace.

TIN:

Alloy Ally

As a hard-working partner of copper, lead, zinc, nickel, cadmium and other metals, tin is an effectual ally in many an alloy.

Now tin can do still more work for you.

With the end of U.S. Government controls, tin is again freely available—to *any* user, in *any* quantity, for *any* purpose.

And new purposes for this vital metal—new ways in which it can work to make better products at lower costs—are constantly being developed.

Over 1/3 of the world's tin is mined in Malaya. No end is in sight, geologists say, to these important reserves.

So don't let needless concern about future supplies keep you from making profitable use of versatile tin.

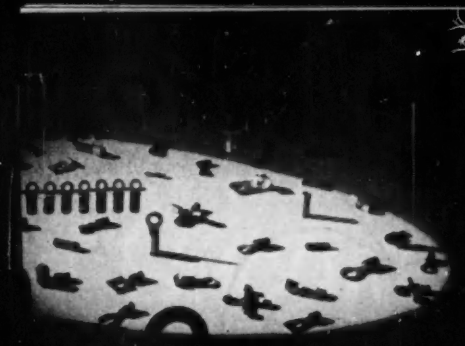
Remember, no other metal has all the properties of tin. Tin is inert, nontoxic, friction and corrosion resistant. Tin is highly malleable, second only to gold. Above all, tin is economical to use. A little tin will do a lot of work.

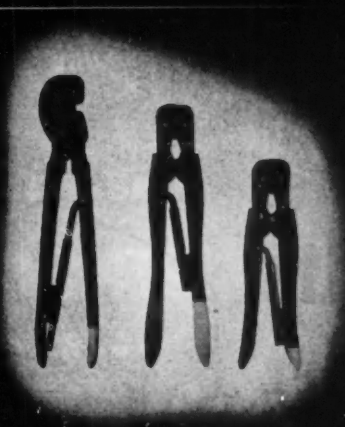
This is the time to investigate thoroughly the ways it can work for you.

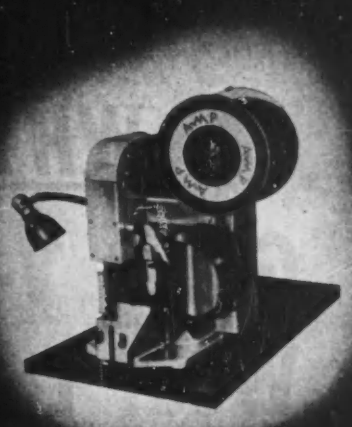
This Bureau is sponsored by the tin producers of Malaya to promote better understanding between America, world's largest consumer of tin, and Malaya, world's largest producer. TIN NEWS, issued monthly, will keep you and 8000 other U.S. readers posted on new developments. It's yours, free, if you'll send us your name and address.

Now tin may be purchased by any user—in any quantity—for any purpose.

THE MALAYAN TIN BUREAU **Dept. 463, 1028 Connecticut Ave., Washington 6, D.C.**





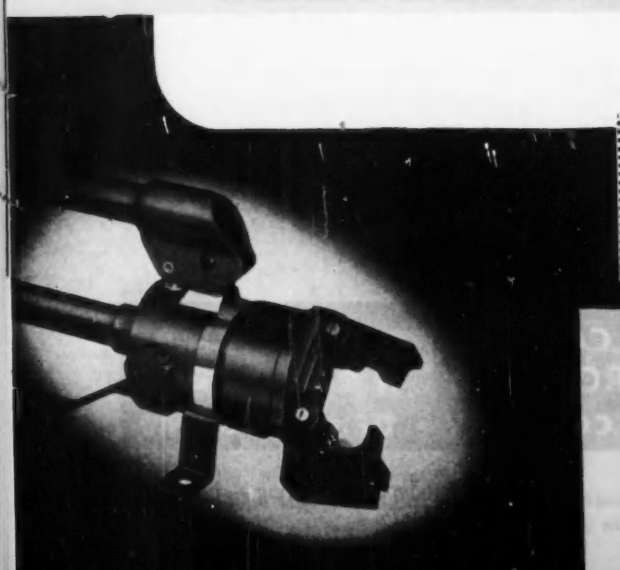


"Branded" so you KNOW it's right

AMP tools and terminals are members of a made-to-use-together team. They're made so that you can be *sure* you have a correctly installed termination. With AMP tools, the small DOT CODE "brand" gives an immediate check that the right color-matched tool has been used with the right color-matched terminal. This is just one more AMP control feature that insures the correct installation of your wire terminations day in, day out on the line—where it counts!

A-MP DOT CODE WIRE TERMINATION CONTROL

YOU CAN COUNT ON AMP



AMP

AMP

AIRCRAFT-MARINE PRODUCTS, INC.
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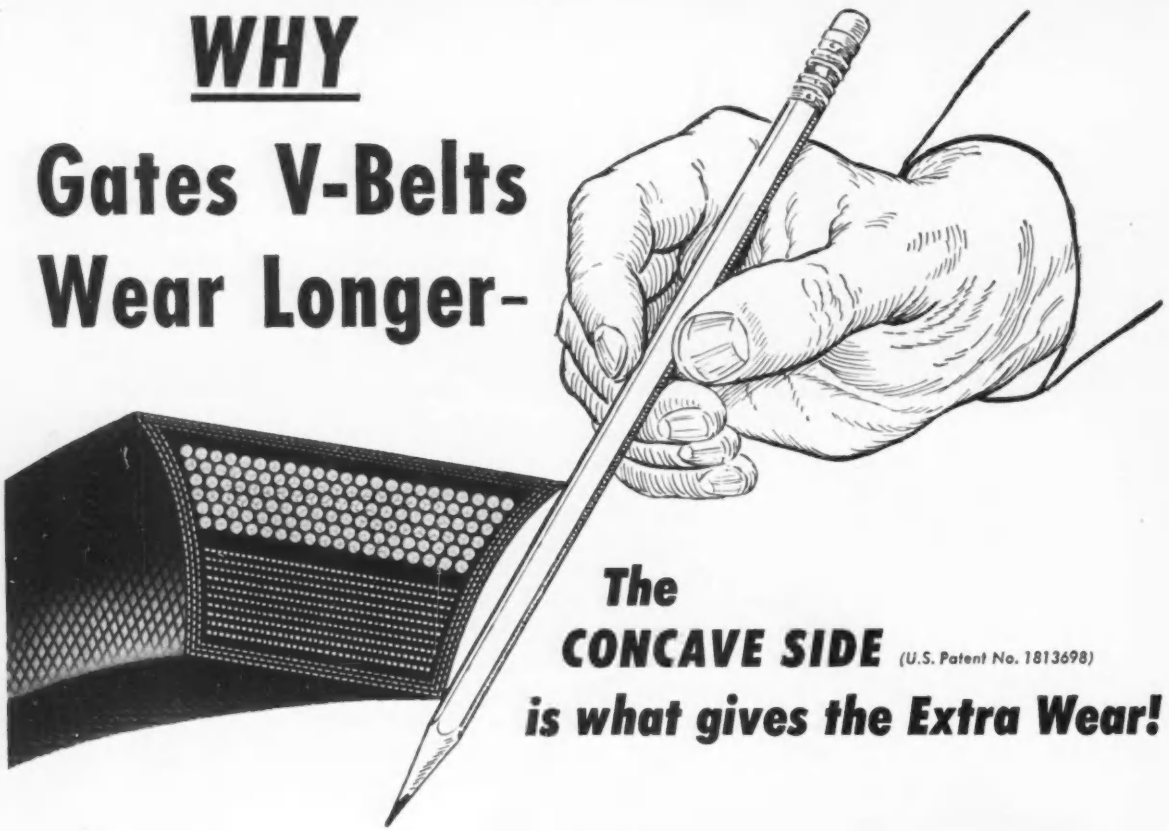
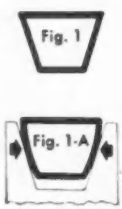
WHY
Gates V-Belts Wear Longer-



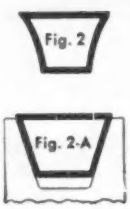
The CONCAVE SIDE (U.S. Patent No. 1813698) is what gives the Extra Wear!

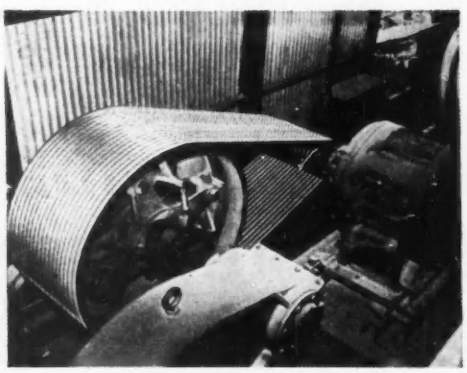
Take any *straight-sided* V-Belt (Fig. 1) and bend it as it bends in going around its pulley. You will clearly see its sides *bulge out* (Fig. 1-A). These sides therefore press *unevenly* against the V-pulley and this causes extra wear at the point shown by arrows (Fig. 1-A).



Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2).

You will see the precisely engineered CONCAVE SIDES fill out to an exact fit in the sheave-groove (Fig. 2-A). The sides press *evenly* against the V-pulley. All wear is distributed *uniformly* across the *full width* of the Gates Vulco Rope—and this means longer belt *life* and *lower* belt *costs* for you.





Typical Gates Vulco Rope Drive—the Gates V-Belts are built with Concave Sides to insure longer belt wear.

When you buy V-Belts, be sure to get the V-Belt with the CONCAVE SIDES—the Gates Vulco Rope!

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and in 71 foreign countries.

CS-533

V-Belts – Hose
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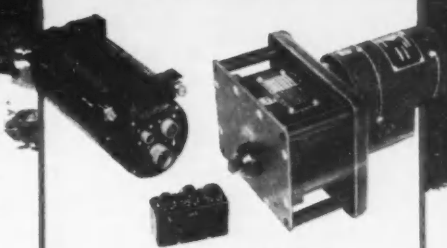
NORTH AMERICAN'S F-86D
SMOOTH FLIGHTS
AT SUPERSONIC SPEEDS

A nine-ton bullet hurtling through space at 10 miles per minute takes some handling. That's why the North American F-86D uses Lear controls.

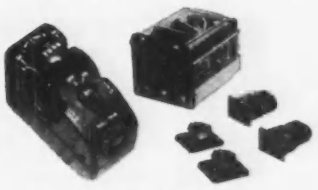
Smoothly and automatically the Lear designed F-5 Autopilot ... the lightest weight production Autopilot in use in jet fighters ... puts this fast jet plane through her paces. Lear Damping Controls augment the plane's natural stability and allow smoother flight over the plane's air-speed range. Lear Vertical Gyro Indicator Systems instantly and accurately present a true picture of the plane's attitude.

In jet fighters, bombers, transports and airliners Lear Control and Actuating Systems and Components are making flight smoother, faster, more economical —and safer.

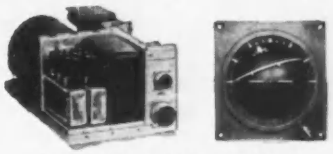


LEAR DAMPING CONTROL SYSTEM

... anticipates and measures rate of deviation from established heading and applies corrective force to control system through Lear Servo-Actuator.



AUTOMATIC PILOTS



VERTICAL GYRO SYSTEMS

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AUTOMATIC APPROACH COUPLERS AND FLIGHT CONTROLS • CONTROL MECHANISM GYROS • REMOTE READING GYRO INSTRUMENTS • RATE GYROS MISSILE FLIGHT CONTROLS

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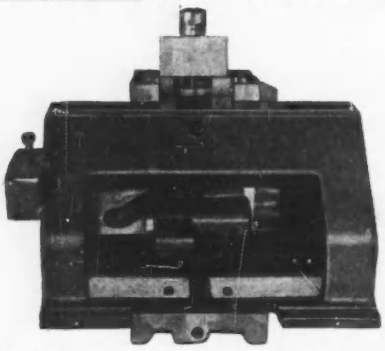
LEAR, INCORPORATED, GRAND RAPIDS 2, MICHIGAN

SPEED STEELS are finding new uses every day!

SPEED ALLOY USED FOR CAMS*

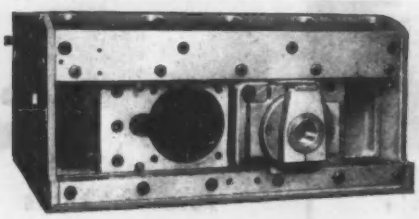


Lodge & Shipley Co., Cincinnati, Ohio, found Speed Alloy well suited for cam plates in the cam operated cross slide of their 2A Duomatic Lathe . . . report considerable saving in machining time over other suitable alloys . . . cam slot in plate is carburized and heat treated to 50-55 Rockwell C. This surface hardness is readily attainable with good core hardness to back up the case. Reduced distortion obtained is very desirable in this part.

SPEED TREAT USED FOR TRANSFER CYLINDER PLATE*

General Riveters, Inc., Buffalo, New York, use Speed Treat plate for the transfer cylinder plate on their "Drivmatic" Drilling-Countersinking-Riveting machine. Plate as machined is 1" x 8" x 18". Speed Treat selected because of machining ease and it assures necessary toughness after heat-treating.

***Typical case studies from our files.**



THE SPEED STEELS

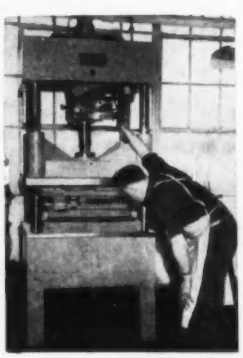
SPEED ALLOY A hot rolled alloy steel plate. Bridges the gap between carbon and tool steel. Ease of machining, moderate cost, and wide range of physical properties obtainable by varying heat treatments allow wide diversity of use ranging from machined parts to zinc die casting dies and plastic compression molds.

SPEED TREAT (X1545) A medium carbon, open hearth steel plate. Its .45% carbon and 1.25% manganese content, gives it a versatility that makes possible many time-saving short cuts and improved engineering techniques. Machinability only slightly less than B-1112. Machines with no tendency toward tearing —longer tool life. High lustre obtained with minimum polishing. Especially suited for flame or induction hardening as well as other treatments. Readily welded. Ideal for rubber molds and plastic cavity retainer plates, hardened gears and sprockets, trimming and blanking dies, punches, machine and equipment parts.

SPEED CASE (X1515) A low carbon, open hearth steel plate. Average analysis is carbon .20%, manganese 1.25% sulphur .25%, phosphorus .02%, silicon .05%. Free machining qualities greatly reduce machining time—increase tool life. Machines with clean, tear-free surface—grinding often unnecessary or a minimum of polishing required. Readily carburized and hardened or welded. Used extensively for rubber molds, die sets, die shoes, gears, sprockets, stripper plates, jigs, fixtures, machine parts.

SPEED CASE IDEAL FOR PLATENS*

Dake Engine Co., Grand Haven, Mich., employs Speed Case plate for the platens on their air-hydraulic die try-out presses, which have a double-acting 50-ton capacity. Platens formerly made of mild plate . . . Speed Case now used because it cuts machining time, provides better finish, assures greater strength.



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(INC.)

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Plants: Hammond and Indianapolis, Indiana

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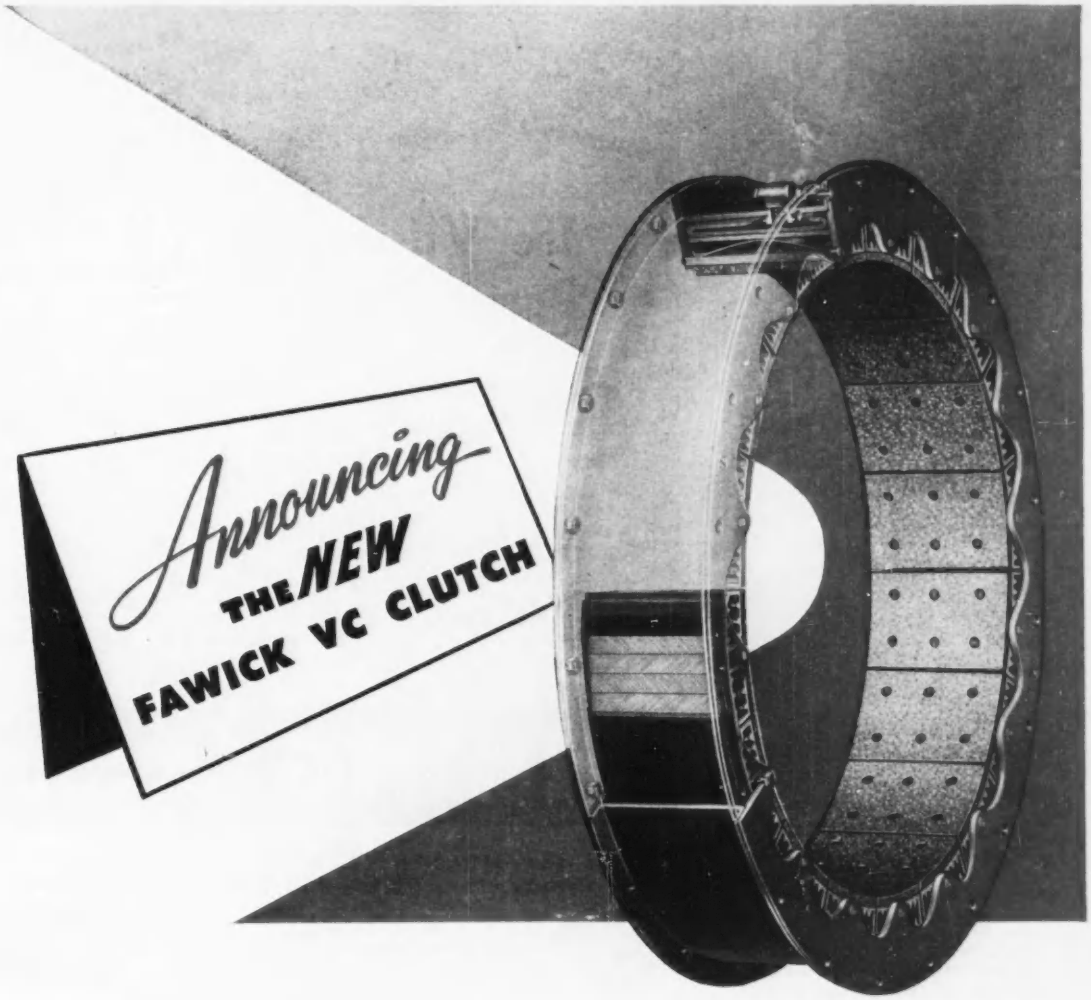

The NEW completely-ventilated
FAWICK TYPE VC *Air-Ring* CLUTCH.

FAWICK announces another air-operated clutch advancement. The NEW FAWICK TYPE VC *Air-Ring* CLUTCH is specifically designed and built to fit the needs of manufacturers and users of heavy equipment on the roughest applications.

Design features found only in this NEW VC CLUTCH include:

1. Cooler operation inherent in drum clutch design *plus* isolation of the operating tube from the heat-generating friction surface.
2. Riveted, Replaceable Friction Lining.
3. Loose, Expanding Operating Tube which can be replaced without removing clutch from shaft.

The FAWICK Rigid-Type VC CLUTCH is unmatched for heavy-duty service with high-starting loads and sustained slippage where generated operating heat lowers clutch efficiency and shortens operating life. With its cooler operation the FAWICK VC provides "new clutch" performance throughout a long maintenance-free life.

For further information on the NEW FAWICK VC CLUTCH write to the main office, Cleveland, Ohio, for Bulletin ML-102.

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COLD HEADING AND ROLL THREADING PROCESSES MAKE BETTER PARTS...
STRONGER, FASTER CHEAPER

Countless small parts usually made by conventional turning processes — by stamping, drawing, casting or molding — can be made *better . . . stronger . . . cheaper* by *cold-heading* and roll threading.

Machining of Cold-Headed Parts is hardly ever necessary because shank and head dimensions can be held to very close tolerances. Rolled threads are produced to American Standard dimensions.

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Bolts	Thumb Screws	Arms
Studs	Wing Nuts	Plugs
Rivets	Small Gears	Prongs
Rods	Tongue—Clevis	Points
Links	Segments	Hooks

Single or multiple secondary operations can be performed on cold-headed parts to produce special characteristics required to fit the part for its particular application. These secondary operations include drilling, tapping, milling, shaving, flattening, notching, flanging, trimming, serrating, bending, off-setting, slotting, fluting, swaging, knurling, pointing, heat treating, plating and finishing.

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JUMPER STRIP Eliminates wiring for common circuits
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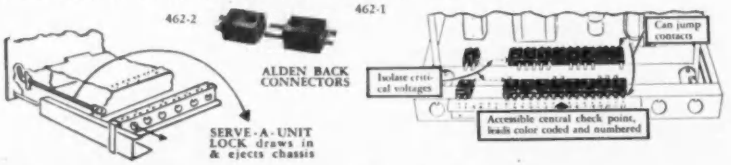
YOUR COMPLETED CIRCUITS FOR PLUG-IN PACKAGE OR CHASSIS

You can use Alden Terminal Mounting Card with Alden Miniature Terminals, Jumper Strip and Sockets staked to accommodate any circuitry — making complete units ready for housing. Components snap into unique Alden Terminals, are held ready for soldering.

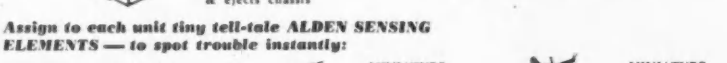
2. *Mount this compact vertical circuitry in neat accessible ALDEN PLUG-IN PACKAGE OR CHASSIS*

Alden components provide standard plug-in or slide-in housings—with spares, your circuits become units replaceable in 30 seconds.

3. *Use ALDEN BACK CONNECTORS and SERVE-A-UNIT LOCK for 100% circuit accessibility and 30-second chassis removal.*



4. *Assign to each unit tiny tell-tale ALDEN SENSING ELEMENTS — to spot trouble instantly:*



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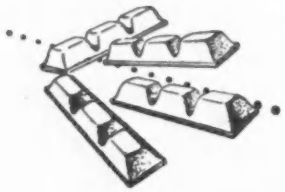

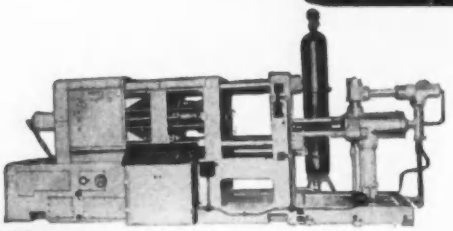

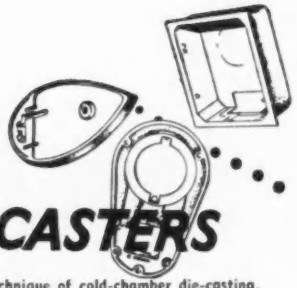

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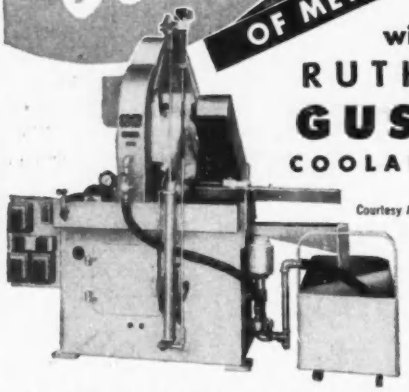

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Illustrated is a Campbell 406 Wet Abrasive Cutting Machine equipped with a Ruthman Gusher Coolant Pump.

Costs are down when you use a Gusher, for Gusher Coolant Pumps assure you efficient operation and long trouble-free life.

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Baltimore, Md. — Colliflower, Inc., Baltimore National Pike, Ellicott City, Md.

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Detroit, Mich. — Fors Sales Co., 2832 East Grand Blvd.

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St. Louis, Mo. — William Scheer Co., 6376 Clayton Road

Tulsa, Okla. — John G. Burke & Co., P.O. Box 1652

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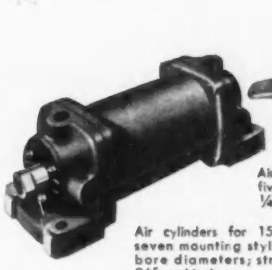
Salt Lake City, Utah — J. M. Grisley Machine Tools, 375 S. W. Temple Street

Los Angeles, Calif. — Paul-Munroe Company, 4867 E. Gage Ave., Bell, California

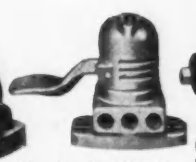
San Francisco, Calif. — Ditzen Engineering and Sales, 5275 Claremont Ave., Oakland 9, Calif.

Oregon and Washington — Hydraulic Power Equipment Co., 2316 N.W. Savier Street, Portland, Ore.

Canada—D.M. Duncan Machinery Co., Ltd., 1958 Wyandotte St. East, Windsor, Ontario; 197 College St., Toronto, 2B

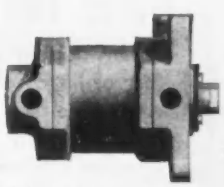


Air cylinders for 150 P.S.I.; seven mounting styles; nine bore diameters; strokes to 96"; cushioning.



Air valves for 150 P.S.I.; five kinds of operation; ¼" to 1" sizes.

Hydraulic valves for 1500 P.S.I. up to 3000 P.S.I.; 4 types of action; 5 piston designs; 6 operations; ¼" to 1½".



Hydraulic cylinders for 300, 1500 and 3000 P.S.I.; 7 mountings; 10 diameters; strokes to 96"; standard and 2:1 rod; cushioning.

Power units .4 G.P.M. to 40 G.P.M. at 1000 P.S.I. Double units 3 G.P.M. and .4 G.P.M. to 40 G.P.M. and 12 G.P.M. at 1000 P.S.I.

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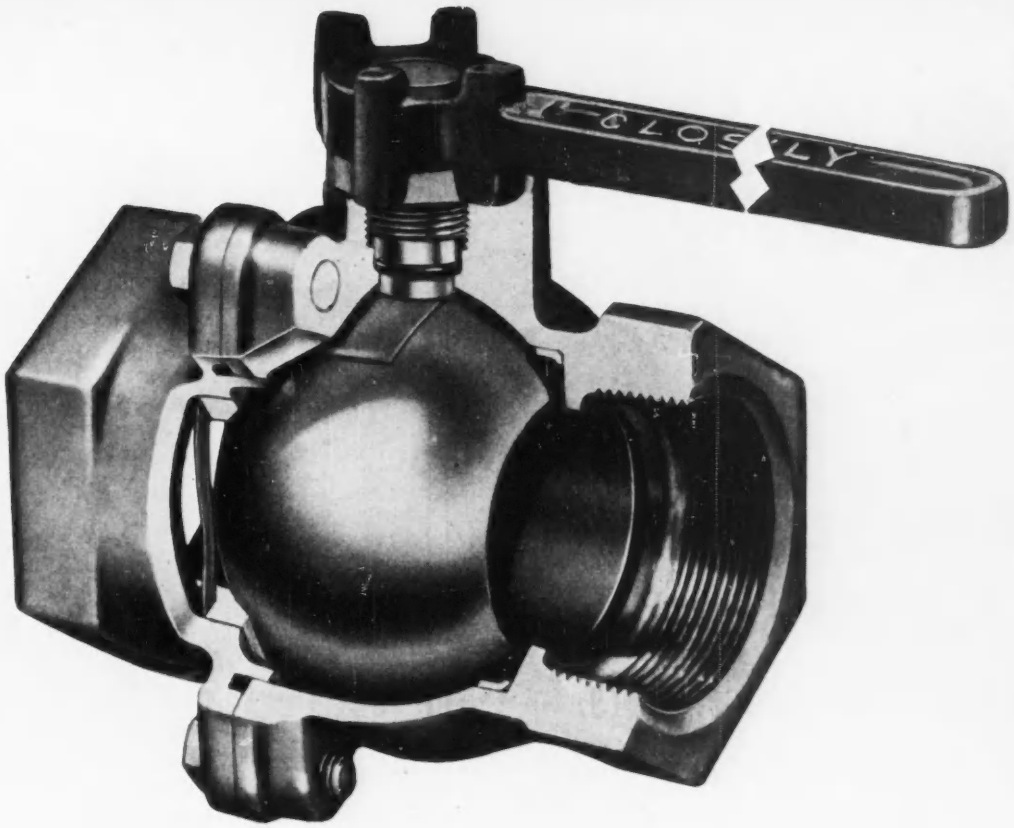

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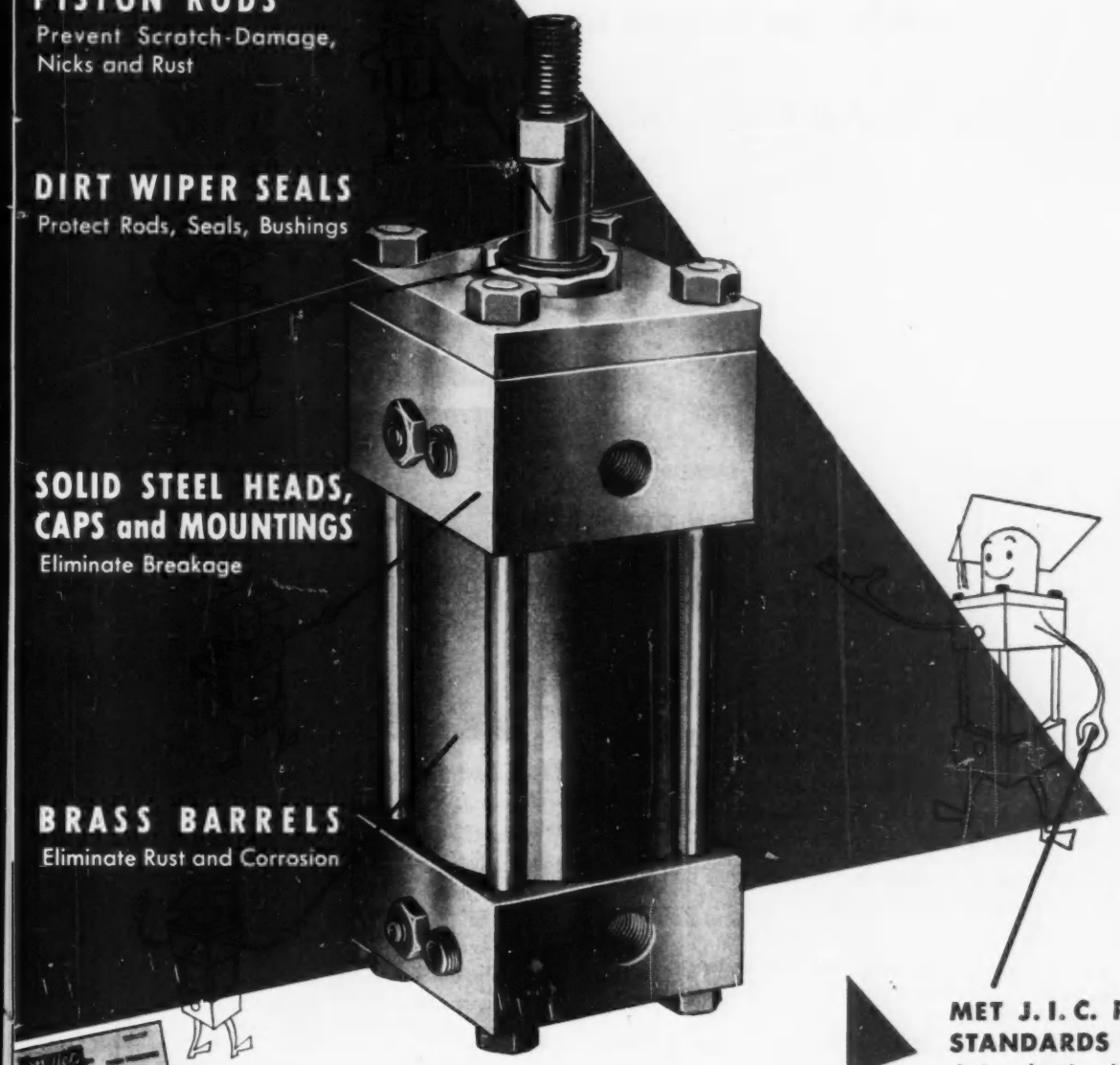

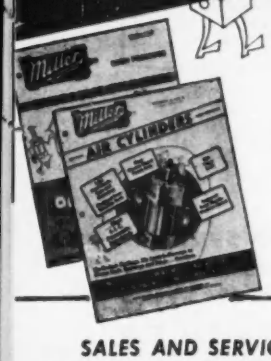

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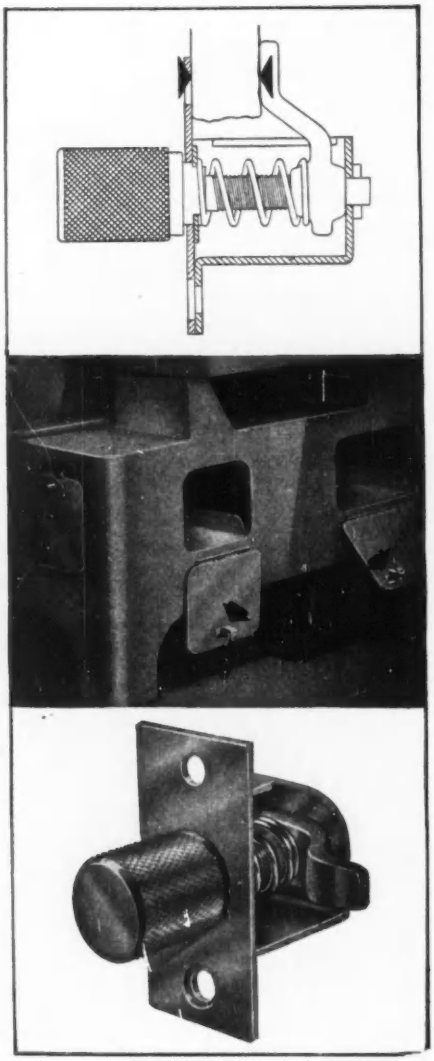

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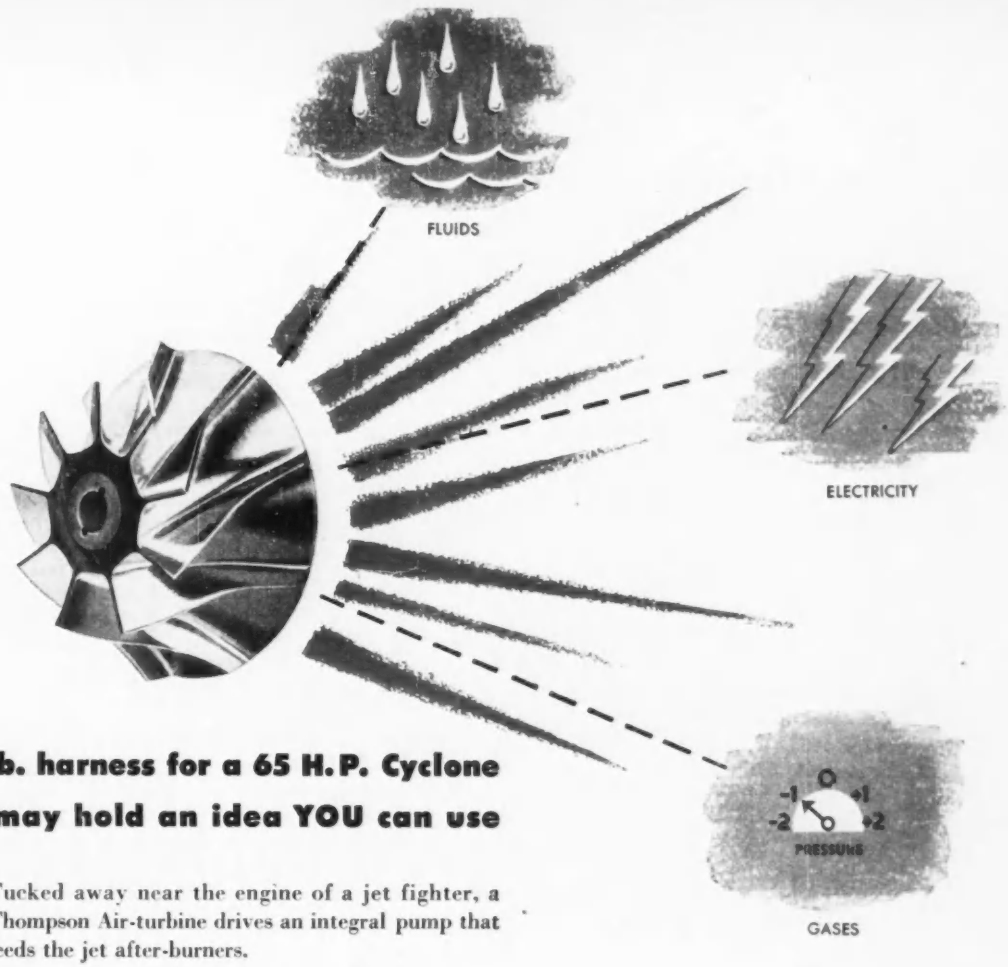

This 12 lb. harness for a 65 H.P. Cyclone ...may hold an idea YOU can use

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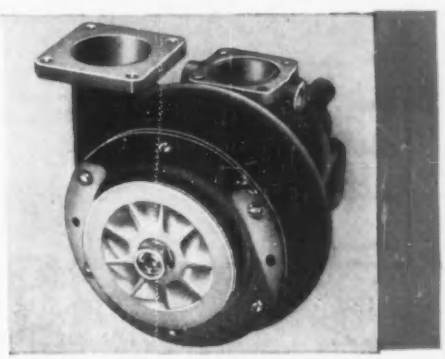

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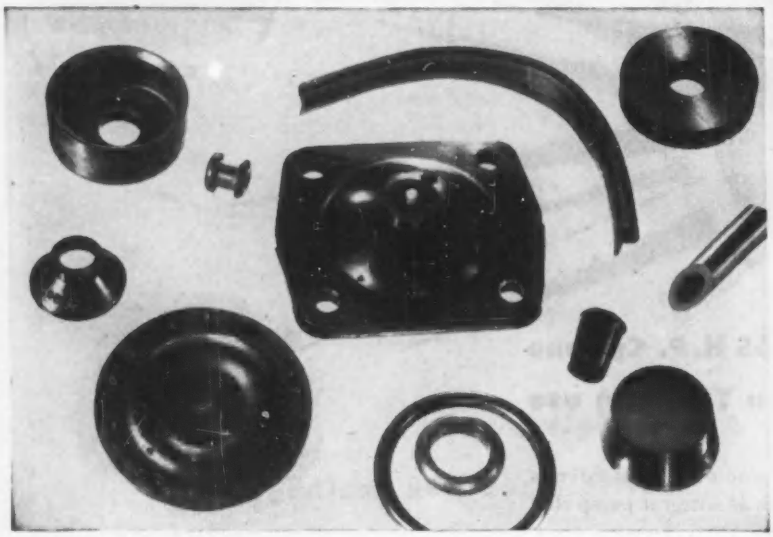

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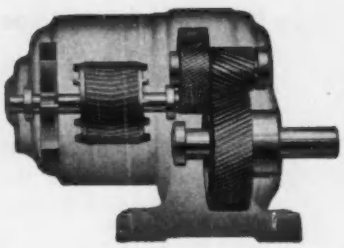

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—product performance that can come only from a "know-how" that has grown through actual service since the early days of the electrical industry.

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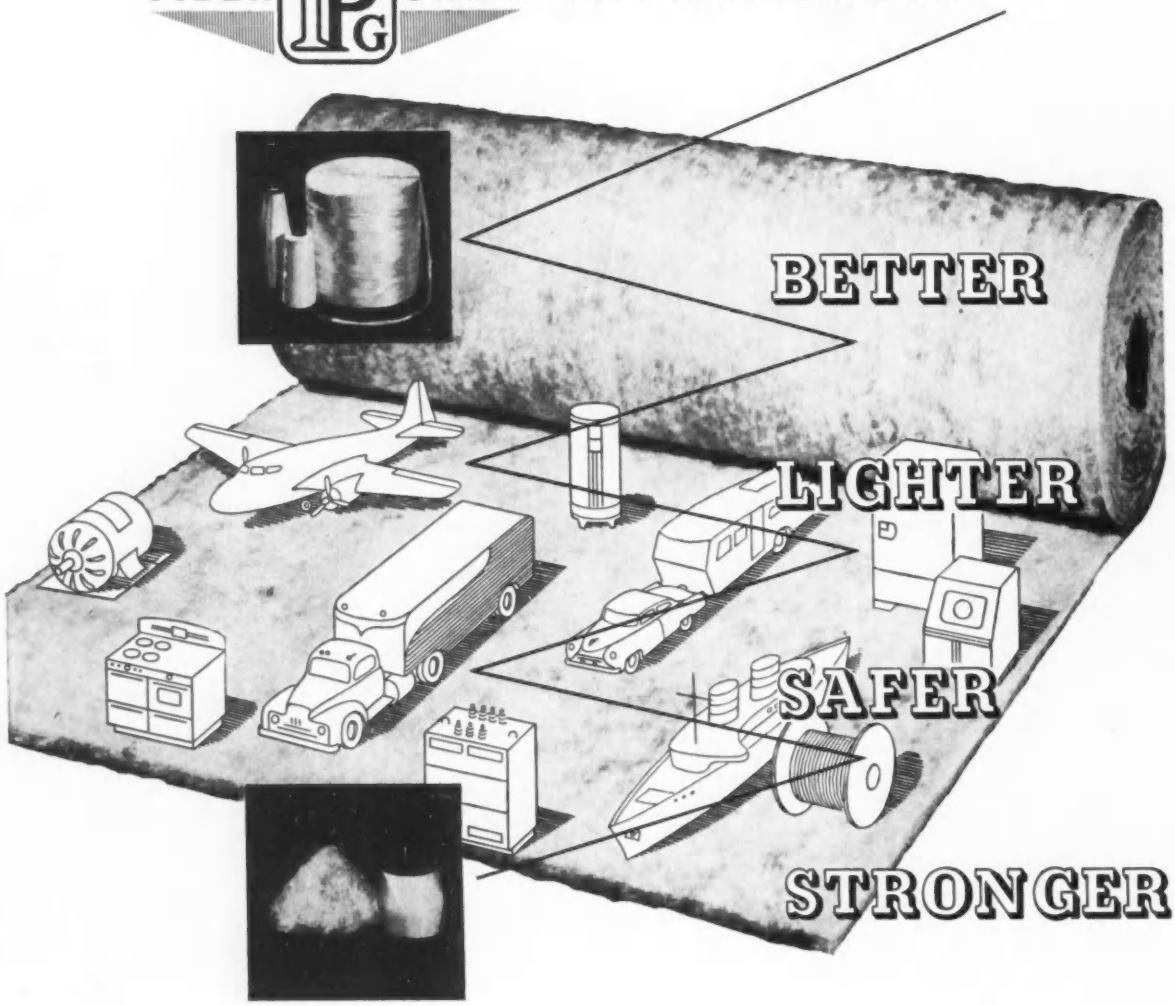

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M3

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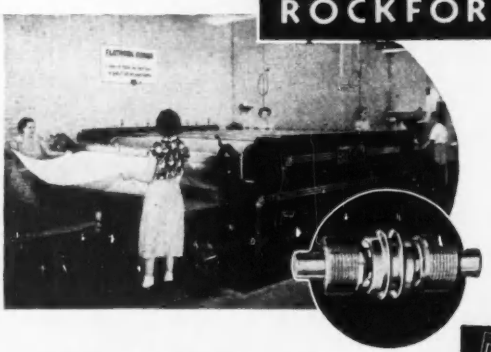

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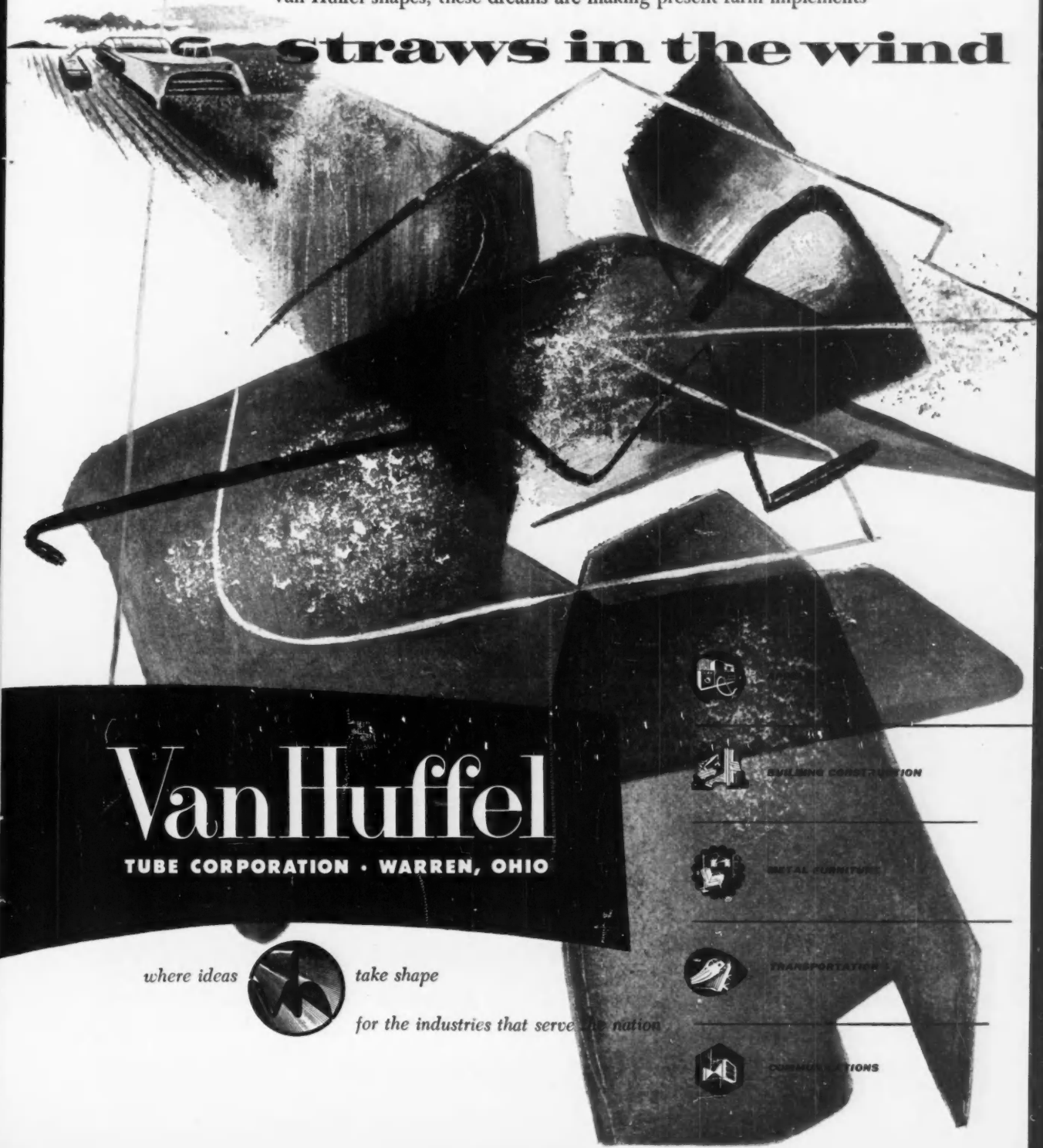

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Gasket Materials to Tolerances of ± 5%

Asbestos-rubber gasket materials by Rogers Corporation feature superior thickness control plus homogeneity and dimensional stability.

UNIFORM AND PRECISE THICKNESS of Rogers DUROID gasket materials assure even compressibility over entire surface of the packing. Now your allowances for gasket thicknesses can be actual — not wishful — and fastening torques can be standardized, an advantage that gains in importance as assembly operations are increasingly mechanized.

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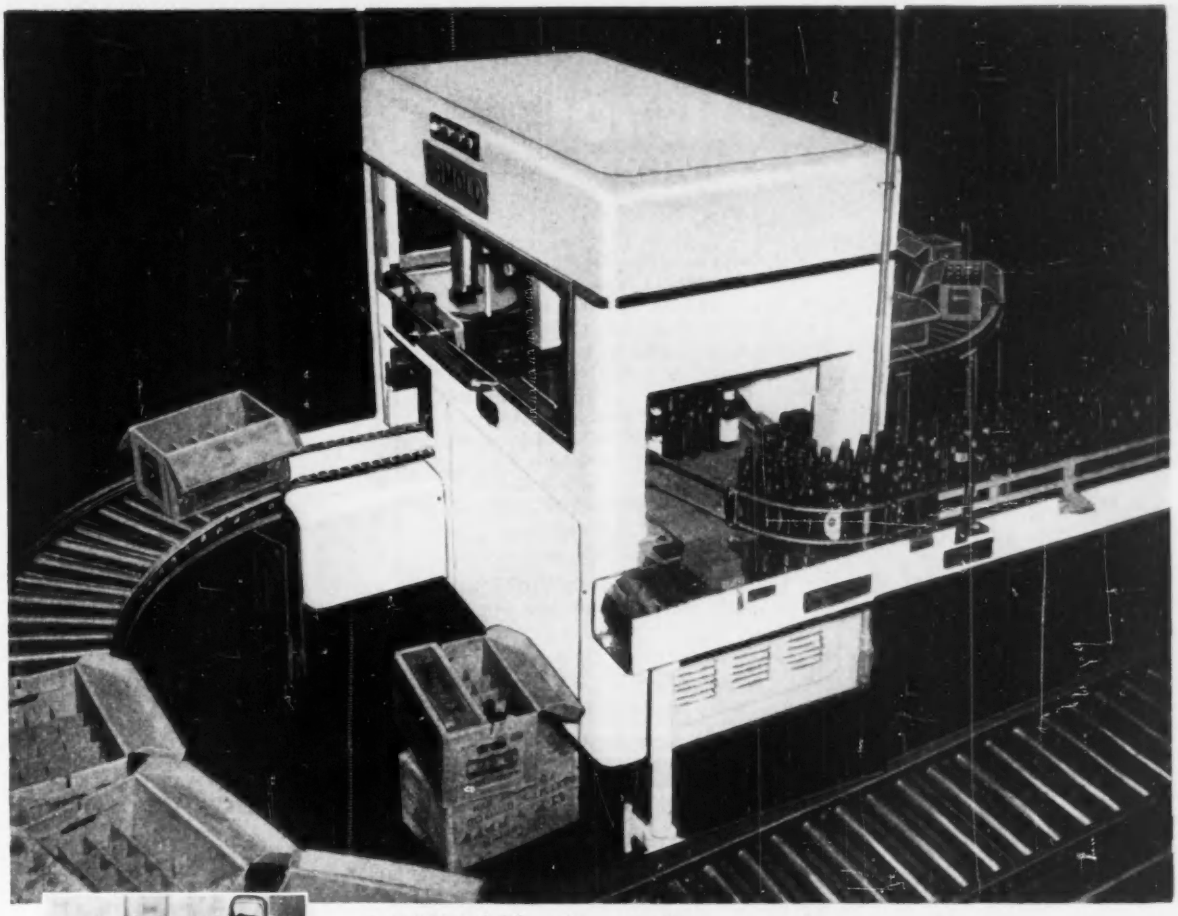
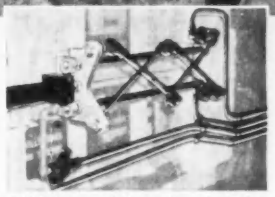
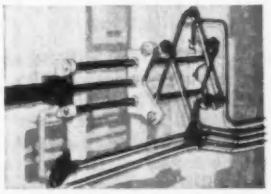
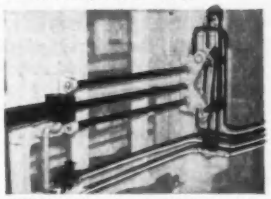




CHIKSAN aircraft hydraulic swivel joints employed in this application permit complete flexibility in contraction and extension of otherwise rigid fluid lines.



CHIKSAN joints allow the Ermold unpacker head to travel backward and forward with the hydraulic lines folding and unfolding automatically.



CHIKSAN aircraft swivel joints enable Ermold to make sharp bends in the hydraulic lines as the mechanism moves forward and backward in the unloading operation illustrated above.

CHIKSAN Flexibility, Safety and Economy END BOTTLENECKS!

When the Ermold Division of The Barry-Wehmiller Machinery Company decided to put out an improved automatic unpacker, it just naturally turned to Chiksan Ball-Bearing Swivel Joints to provide the necessary flexibility and stamina for the electrically-controlled hydraulic system.

This system imparts the motion for precision stopping and starting—for raising and lowering elevating mechanism—for gripping firmly and delicately the most fragile material.

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Well Equipment Mfg. Corp. (Division), Houston 1, Texas

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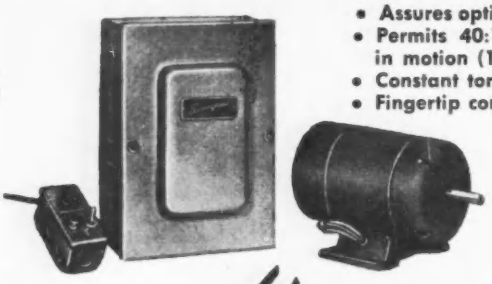
VARIABLE SPEED CONTROL
STOCK DELIVERY



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- ⅛ horsepower — 4000 rpm base speed — 115 volts and 230 volt models, 60 cycles

Uses: Coil winders, life test fixtures, proportioning pumps, printing presses, conveyers, small machine tools, etc.

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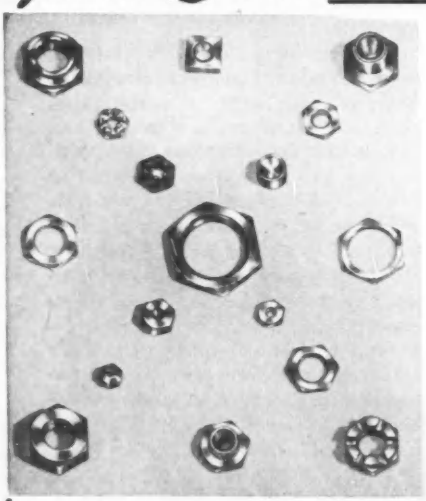
in SPECIAL FASTENERS
Get all 4 with WESTFIELD METAL PRODUCTS



★ **MATERIALS** — Steel, brass, stainless steel, bronze and aluminum.

★ **CAPACITY** — From 3/16" hexagon to and including 1 1/16" hexagon across flats, from 1/16" thick to and including ¾" thick.

★ **THREAD SIZES**—From #2 up to and including ⅞" diameters, any pitches desired.

SEMI-FINISHED MILLED-FROM-THE-BAR STANDARD NUTS
HEXAGON OR SPECIAL SQUARE NUTS
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WESTFIELD METAL PRODUCTS CO., INC.
WESTFIELD, MASS.

What makes the *Annual HANDBOOK* so popular with product-design engineers?

The Annual HANDBOOK of Product Design for 1953, which you received last November, was the *first edition* of this continuing, yearly service to you. Your thousands of inquiries and enthusiastic comments have represented to us the best possible evidence of your enthusiasm for this new service.

Clearly, the *HANDBOOK* brings design-engineers everywhere information they want and need. Into each issue of the *HANDBOOK* go hundreds of pages of product engineering data, carefully selected, edited, and illustrated to give you significant engineering developments as reported during the year both in the U. S. and abroad. Our special *HANDBOOK* staff searches through an array of technical periodicals which could never be adequately read by most busy men, to acquire the most helpful and permanently useful data for inclusion in the *HANDBOOK*.

You'll receive your *Annual HANDBOOK of Product Design for 1954* in November

The *1954 HANDBOOK* will be even *bigger* and more informative than the first edition. Both editorial and advertising pages will be completely indexed, and an index of the *1953 HANDBOOK* will be included. All data and advertising will be divided into ten major classifications, enabling you to locate exactly the subject matter you want quickly.

Your *HANDBOOK for 1954* will be sent to you in Mid-November as part of your regular subscription to *Product Engineering*.

Product Engineering
330 West 42nd St.
New York 36, N. Y.

Prior to the use of Celoron Gears in the textile printing machine shown above, metal gears driven from the main gear had to be replaced after one to two months' operation. They also wore out the expensive main gear, resulting in costly replacement and maintenance, as well as a delay in production.

But since installing nine C-D-F Celoron gears over a year ago, there has been no wear on the main gear, no replacement of Celoron gears. C-D-F Celoron gears are extra strong, extra silent in operation. Celoron maintains its high strength and resiliency at continuous temperatures up to 225° F. Celoron is a laminated plastic produced under high pressures. It resists oil, water, many corrosive chemicals.

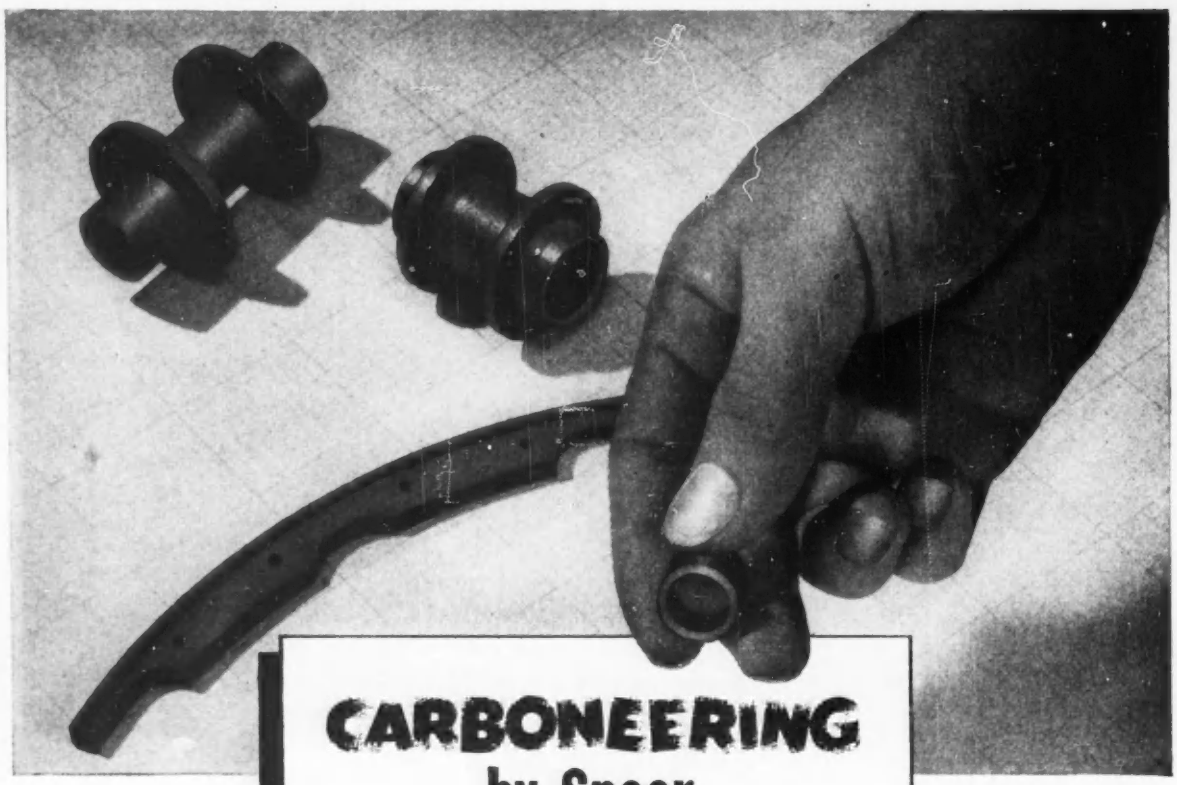
Suitable for many gear applications, Celoron is easily and rapidly machined. Every tooth is of uniform strength. For most gear requirements, Celoron blanks are bandsawed from sheets. Molded blanks can also be furnished. For specific details, see the C-D-F sales engineer (sales offices in principal cities). Or write for Celoron Gear Catalog and plastic machining notebook.

CELORON: **Why don't you "imagineer" with Celoron gears? They have thousands of applications: automotive, textile, printing and metalworking machinery. Celoron has high impact strength. Quiets noisy machinery. If it's gearing you're hearing, talk it over with your C-D-F sales engineer (sales offices in principal cities). He's a good man to know.**

THE NAME TO REMEMBER... CDF CELORON GEARS

Continental-Diamond Fibre Company

NEWARK 40, DELAWARE



CARBONEERING by Speer

source of new solutions to parts-design problems

***You be the judge of carbon's versatility**

Carbon can be:	Carbon has:
Sawed	High corrosion resistance
Drilled	High heat transfer
Milled	Low electrical resistance
Broached	High thermal shock resistance
Turned	High heat transfer (graphite)
Planed	**Carbon is:**
Hobbed	Non-warping
Ground	Not wetted by molten metals
Molded	Chemically inert
Extruded	Self-lubricating (graphite)

SPEER Carbon Co.

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Looking for a "special" material?

Then look at carbon—and Speer *carboneering*. Look at carbon's unique electrical, thermal and mechanical properties—and at the way Speer *carboneers* have put those properties to work in scores of new and varied applications.

Take that small dashpot piston, for example. Made from carbon, it's light, non-warping, self-lubricating and highly resistant to corrosion.

Or those lightweight vacuum-tube anodes, and the diesel engine voltage regulator. Carbon gives them characteristics attainable from no other material. For only carbon offers such an ideal combination of low electrical resistance, high heat transfer, and excellent machinability.

Other examples are virtually endless. They include feather-light resistors and 1300 pound electrodes . . . precision contacts and intricate glass molds . . . trolley wheels for cranes and packing rings for turbines.

If you have a difficult parts-design problem—a problem involving, say, product performance or unit cost—send us the details. Carbon and Speer *carboneering* may well hold the answer.

What problems face you...

Ni-Resist provides a ready solution

because

No other cast metal offers such a unique combination of useful engineering properties

Use Ni-Resist® for a specific need or a combination of requirements.

Mechanically Similar to Gray Iron, and resembling austenitic stainless steel in many characteristics, Ni-Resist can solve these problems at moderate cost...

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Please send me booklets entitled, "Engineering Properties and Applications of Ni-Resist," and, "Buyers' Guide for Ni-Resist Castings."

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Company .....

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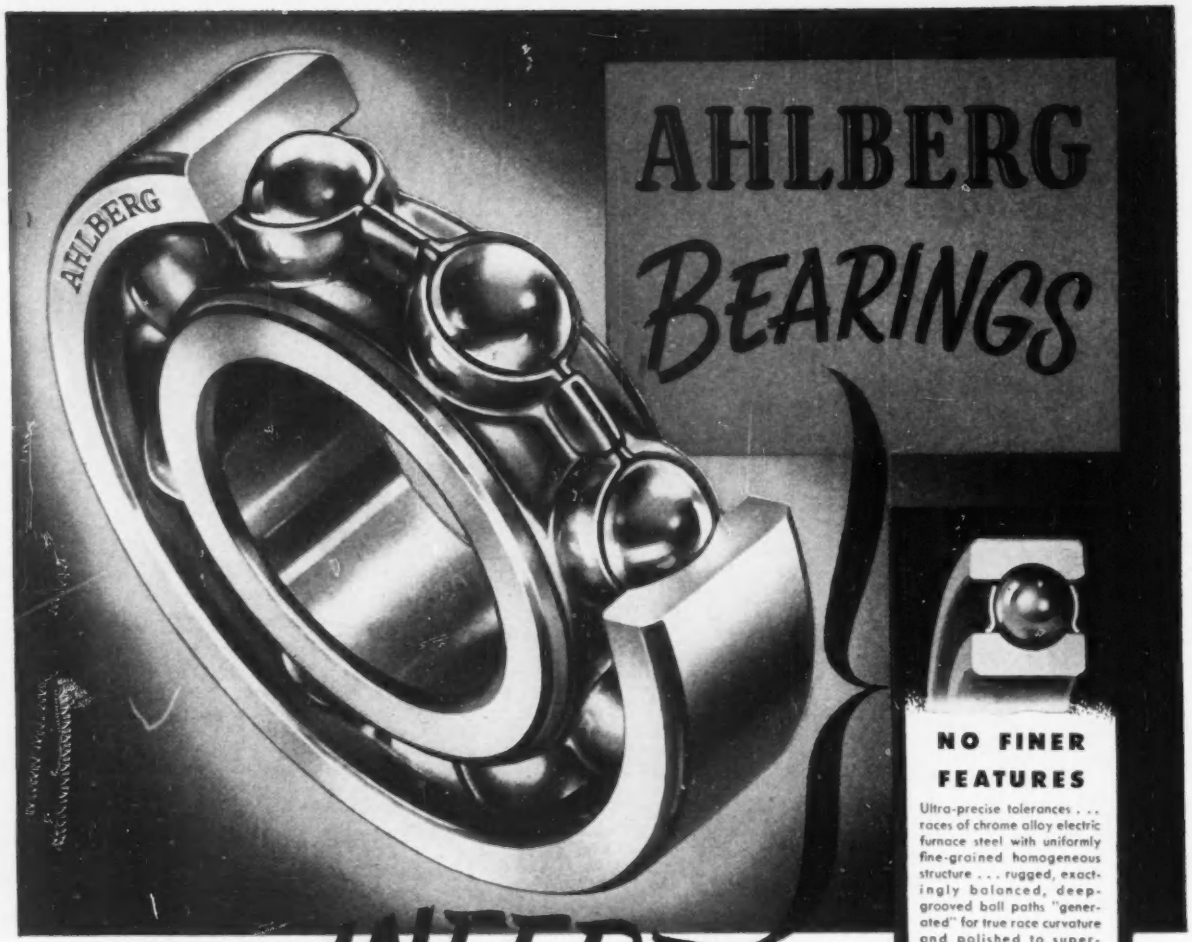

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Ultra-precise tolerances . . . races of chrome alloy electric furnace steel with uniformly fine-grained homogeneous structure . . . rugged, exactingly balanced, deep-grooved ball paths "generated" for true race curvature and polished to super-smoothness . . . micro-lapped chrome steel balls matched in sets and sphericity to within .000025".

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TO COST LESS BY LASTING LONGER

We've seen the time, in this business of ours, when bearing users often made their selections on a look-alike, serve-alike theory. But technological progress, the squeezing of machinery tolerances, the stepped-up speeds and loads required in our modern mechanized world have long since changed all that—a change we've welcomed because Ahlberg bearings have always been designed and built on the principal that there is no substitute for quality—that only longer-lasting, ultra-smooth running bearings are actually an economy.

Next time you design a new machine or modernize an old one, a point by point comparison will give you convincing proof of Ahlberg superiority and further evidence of how better bearings make better products. We'll be glad to collaborate closely with your engineers and submit quotations without obligation. Write today! Ahlberg Bearing Company, 3025 West 47th Street, Chicago 32, Illinois.

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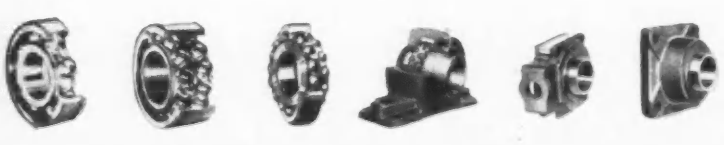
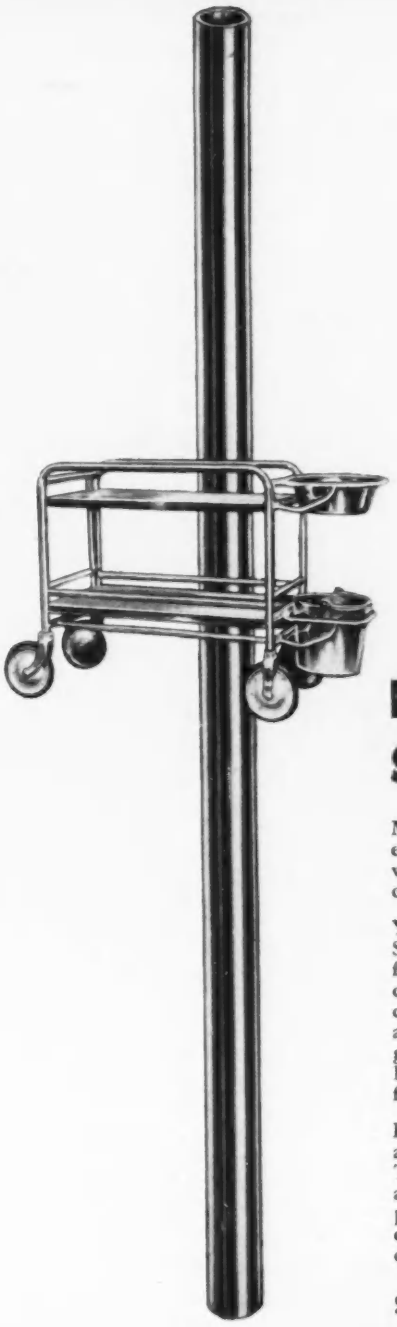
PRECISION CRAFTSMEN SINCE 1908



BALL BEARINGS • • • ROLLER BEARINGS • • • THRUST BEARINGS AND BALL BEARING HOUSINGS



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Maybe your product has to be attractive. Or sanitary, easy to clean. Or strong, and long lasting. Maybe you want high resistance to heat and corrosion. Easy fabrication. Low end cost.

You'll find all these advantages in ELECTRUNITE Enduro Stainless Steel Tubing and Pipe. Formed from clean, flat-rolled steel. Uniform wall thickness . . . uniform concentricity . . . uniform quality, inside and out. You can bend them. You can join them by fusion or resistance welding. Or solder them. Or braze them. You can grind, polish or buff tubing to a mirror-like finish . . . I.D., O.D., or both. Or Republic will do it for you. We'll fabricate it, too.

ELECTRUNITE Enduro Stainless Steel Tubing and Pipe are available in a variety of chromium-nickel analyses. Tubing also in type 430. The type that fits your particular application . . . properly used . . . can pay its way in better performance and lower maintenance costs. Republic engineers and metallurgists will be glad to help you choose it. For design data and specifications, write to:

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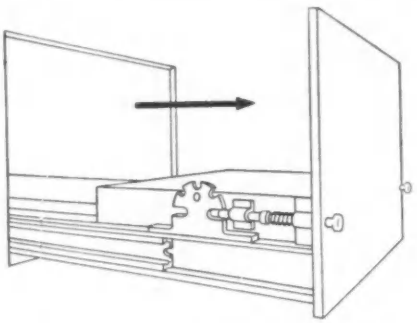
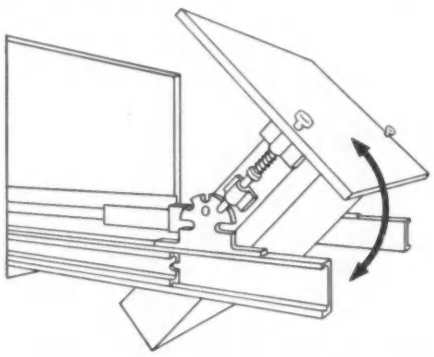
PRODUCED BY THE MAKERS OF ELECTRUNITE — THE ORIGINAL ELECTRIC WELDED BOILER TUBE

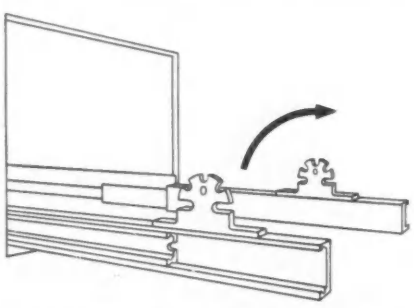
slides to **full** extension



tilts, locks securely

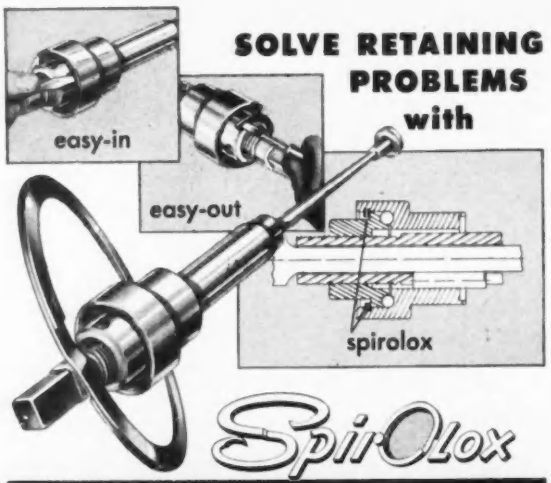


completely **removable**



grant industrial slides

Does this kind of action suggest applications in your field? If your design problem requires sliding motion (up to 500 lbs. load) plus tilting (+90° or −90°, and any intermediate angles) plus positive locking — or any one of these — ***you will do well to consult "the foremost name in sliding devices."*** **Write to Grant Pulley & Hardware Company, 31-77 Whitestone Parkway, Flushing, New York.**



SOLVE RETAINING PROBLEMS with

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Retaining Rings

With Spirolox you are assured of quick, easy installation and removal of the retaining ring. As illustrated by this installation on a tube-cutter assembly, Spirolox is inserted in a jiffy, removed with a flip of a screwdriver. No special tools needed.

Simplified, trouble-free solutions to retaining problems like this are possible because of extraordinary Spirolox flexibility and conformability. Unique two-turn construction lets you spiral-in a Spirolox ring quickly and easily. Complete elimination of lugs or projections, breaks or gaps, provides uniform shoulder which conforms 100% to diameter of groove.

SEE OUR CATALOG IN SWEETS FOR PRODUCT DESIGNERS

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108

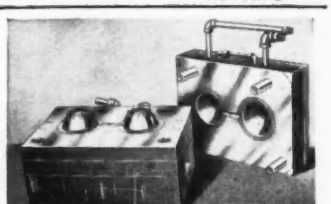
SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!

PYRO Pyro Plastics

Starting Point for a Better Product

VOLUME 1 NUMBER 3

HOW TO LOWER YOUR MOLD COSTS!



Exhaustive research by PYRO engineers and technicians has resulted in the development of new injection molding machines which enable PYRO to use small, relatively low-cost molds with fewer cavities for economical production of plastic parts.

Now PYRO can solve your injection molding problems and save you money by the elimination of the need for large, expensive multi-cavity molds. If your parts are suitable for this special equipment, tool costs can be reduced by as much as 40 to 70%, and yet obtain competitive production prices. Fewer mold cavities also means better quality control.

Investigate now! Send your part designs and complete information to PYRO for prompt, money-saving quotations. Complete injection molding services under one roof: Product Design and Development, Engineering and Tooling, Production and Assembling. Why pay more than necessary? It will pay you to check with PYRO.

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The new ALLEN BUTTON HEADS are here

. . . and ALLEN ⬡ SOCKETS have the strength to make this new type practical

Button head cap screws provide smooth streamlined surfaces which are desirable in many applications that do not permit countersinking. However, their sockets are necessarily shallower than those of standard socket cap screws.

This makes it doubly important to be certain you specify genuine *Allen ⬡ Button Heads.* The basic superiority of Pressur-Forming and Allenoy steel provide ample socket strength for satisfactory use, even with the shallower socket.

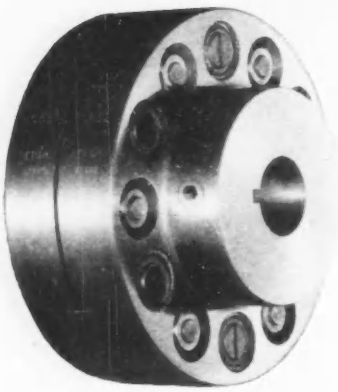
Sizes from #8 x ¼" through ⅜" x 2" standard with NC threads. These sizes also standard with NF threads except in ½" and ⅜" diameters.

Sold only through Leading Industrial Distributors

AJAX

FLEXIBLE couplings

Standard For 30 Years



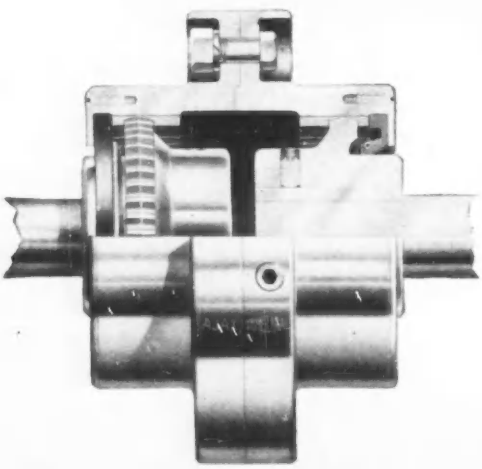
★ Ajax Rubber-Bronze Bushed and Neoprene Couplings combine positive drive with resilient flexibility for protecting direct-connected machines. They are made in a wide range of sizes in standard, shear pin, bolt-on, brakedrum and other types. Available with flanges made of cast semi-steel, drop forged steel, aluminum and bronze to suit requirements. Write for catalog.

AJAX DIHEDRAL

couplings

Designed to Handle Misalignment up to 4°

TEETH CAN BE CUT TO ORDER TO HANDLE GREATER MISALIGNMENT



★ Save thousands of dollars spent on lining up equipment. Simplifies machine design, installation and maintenance. Exclusive Ajax tooth shape provides for maximum misalignment with tooth clearances (backlash) kept to lubrication film requirements. Positive seals keep lubrication in and dirt out. Write for new bulletins covering standard, floating shaft and mill motor types.

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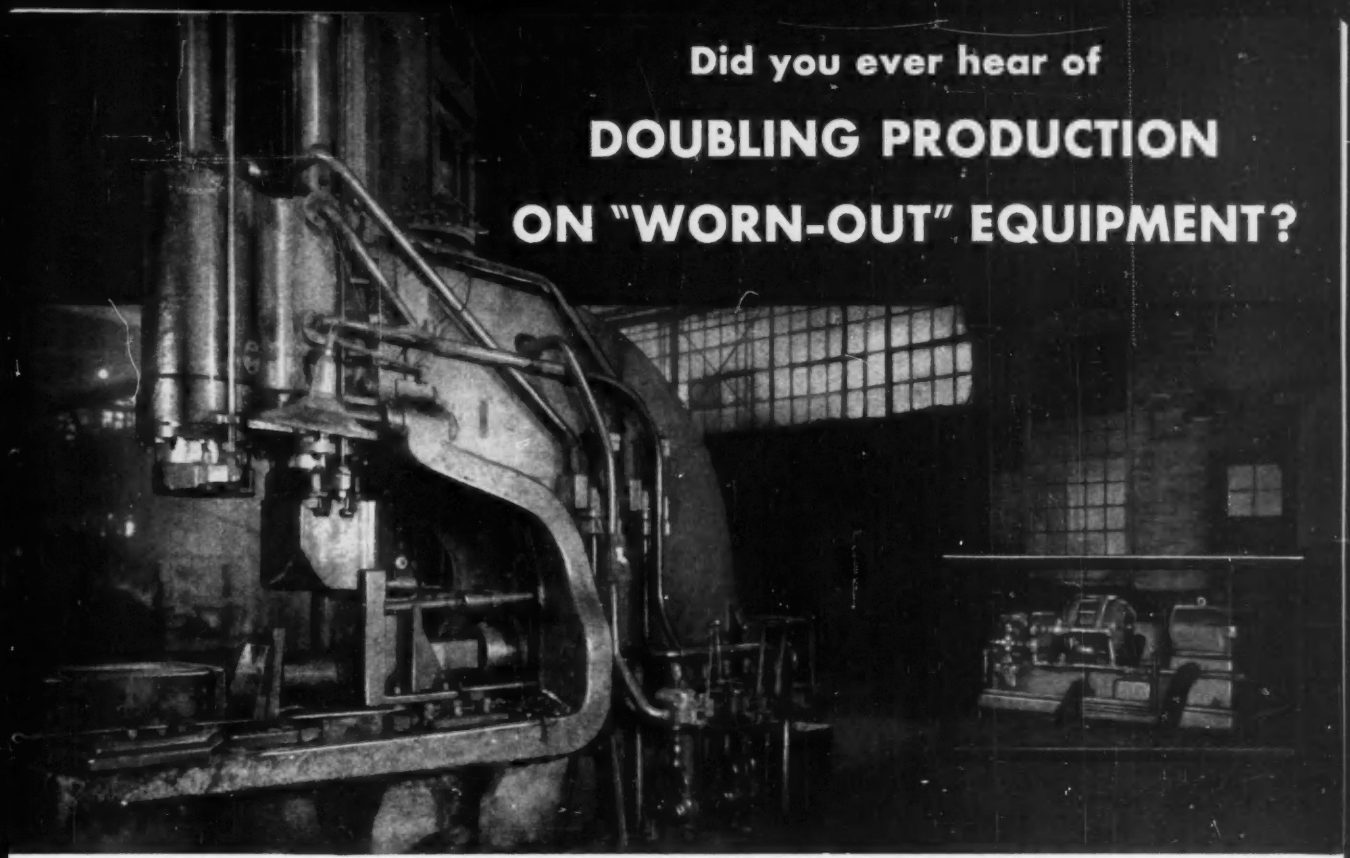

Did you ever hear of DOUBLING PRODUCTION ON "WORN-OUT" EQUIPMENT?

You may gain a valuable hint from this story how Treadwell renovated an old belling machine with Oilgear Fluid Power

The belling machine used for flanging big boiler ends in the Treadwell Corporation plant at Midland, Pa., has seen many years of service. The machine was slow, was "down" a lot, maintenance was high and production was off.

A careful analysis indicated that the press itself was not at fault; the trouble was associated entirely with the water pump, storage and accumulator system used to power the press gripping and main rams.

Two alternatives confronted the Treadwell people. One was to repair or replace the water system. This ran into a figure prohibitively high. It would not solve the problem of high maintenance, faulty control, erratic performance, the shocks inherent in the system, the slow cycles.

The Treadwell people chose the second alternative and called in an Oilgear Fluid Power engineering representative. This is what happened:

A standard Oilgear Fluid Power system was installed, without modification to the press. The only change was some rearrangement of the piping system. The cost was from one-fourth to one-third that of repair to or replacement of the water power system.

The operation of the rams was speeded up, the total time for each cycle cut from 66 seconds to 34 seconds. Therefore actual press production was almost doubled. Because the power medium used is oil, friction and wear become almost non-existent. The space required is slightly less than that required by the water pump, but the bulky water tank and accumulator were eliminated altogether.

The interesting thing about this Oilgear Fluid Power, which is smooth, shockfree and dependable is that from the one source, power travels to actuate the gripping rams, then while holding them at gripping pressure, travels over to the main or shaping ram and actuates it; then the same power retracts the rams in order and goes into "neutral" during the next handling step.

The above is only one of a number of similar press "renovations" being performed with the use of Oilgear Fluid Power.

Think of Oilgear Fluid Power as similar in every respect to electric power. It is generated, piped, and applied in the same way, with these **important** exceptions: Oilgear Fluid Power can be used in linear movement where electricity cannot. Oilgear Fluid Power speed can be varied steplessly, smoothly, infinitely where electricity cannot — or only with costly, troublesome, **extra** equipment. Oilgear Fluid Power can be "bled" off, dissipated harmlessly in case of shock. Oilgear is massive, tremendous, resistless power that can be controlled with micrometer precision.

It is probably the most amazingly versatile power there is. Consider Oilgear Fluid Power to improve the saleability of new machines, to renovate old machines, to solve a hundred troublesome problems where other power has failed to help. It costs you nothing to find out. THE OILGEAR CO., 1571 W. Pierce St., Milwaukee 4, Wis.

OILGEAR

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PRESSURE REGULATORS USE PARKER *Die Castings . . .*

Less than **3%** *rejection on final* **PRESSURE TESTS!**

THE BASTIAN-BLESSING COMPANY manufactures the "RegO" line of liquefied petroleum gas equipment. To the LP-Gas industry "RegO" has become the symbol of quality—the assurance of a complete and satisfying service. The heart of the LP-Gas installation is the pressure reducing regulator—upon its accurate and reliable performance the entire system is dependant. Parker Die Castings were selected because they reduced machining costs to a minimum. On final tests, less than 3% of the castings were rejected—97% met the rigid requirements of tolerance and strength under high pressure. This is another instance when Parker Die Castings are serving industry. Parker Die Castings are economical. You can profit from Parker experience in designing and producing quality die castings for a variety of industrial and commercial applications. Consult with Parker on your next die casting requirements. The result will be mutually profitable.

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Molded plastics bring high costs to bay. Their unlimited color range, smooth finish and adaptability to design offer many production economies. Molded plastic parts cut finishing and fabricating costs . . . eliminate many production steps entirely.

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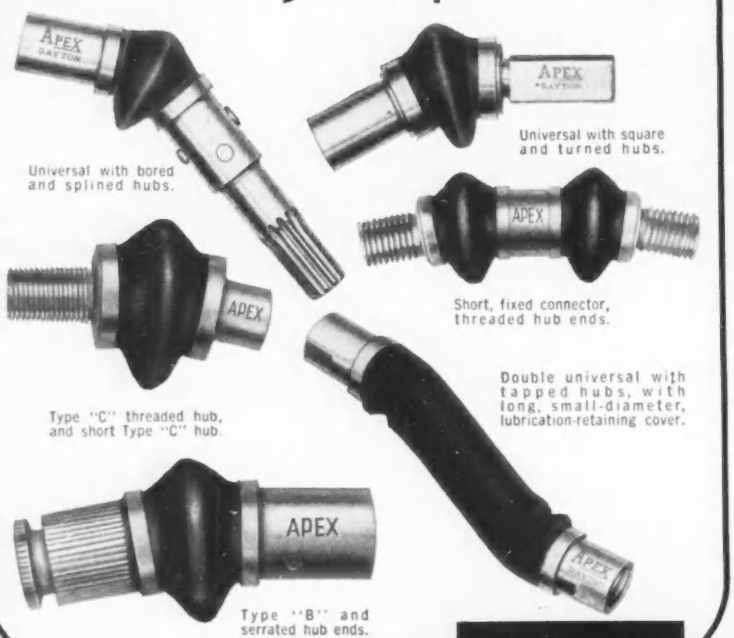
AICO'S Complete Plastic Molding Service Includes: Engineering Counsel; Mold Building; Injection Compression and Cold Molding plus the molding of Reinforced Plastics.

put an "end" to your universal joint problems


Universal with bored and splined hubs.
Universal with square and turned hubs.
Short, fixed connector, threaded hub ends.
Double universal with tapped hubs, with long, small-diameter, lubrication-retaining cover.
Type "C" threaded hub, and short Type "C" hub.
Type "B" and serrated hub ends.
APEX

APEX industrial universal joints are available with these hub types:

THREADED
SPLINED
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BAYONET
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KEY-WAYS

Among the many types of hub ends available on Apex heavy-duty industrial universal joints there's one that will meet your particular requirements. Choose from thirteen stock sizes, 3/8" to 4" diameters, single or double. Sealed, lubricant-retaining covers, standard or flat, insure superior performance on applications where joints are exposed to water, corrosive gases or liquids, dust- or abrasive-laden atmospheres, or extremes of temperatures.

Choose Apex, too, for high overload capacity, superior fatigue resistance, lower deflection rate. On special order, Apex industrial universal joints can be built of bronze alloys, stainless steels or other special materials. Write, on your company letterhead please, for Catalog 27 and Application Data Sheets.

APEX universal joints

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STRAIN GAGE TRANS-DUCERS

For Measurement and Control

This 28-page Special Editorial Report from our November 1952 issue will give you the most up-to-date details on strain gages and this design tool's great versatility.

The first of five sections in this special report covers the two classes of gage—bonded and unbonded, types of bridge circuit, amplifying and recording equipment and the systems combining these components. The four remaining sections take up the different types of transducers designed specifically for measuring pressure, flow, weight and displacement. Case histories follow each transducer section to illustrate some of the more unusual applications for strain gage transducers.

Copies available at 35 cents each.

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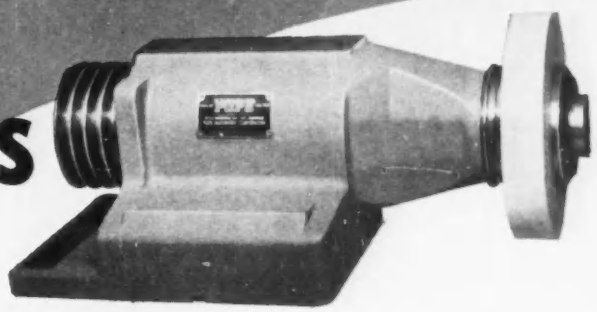
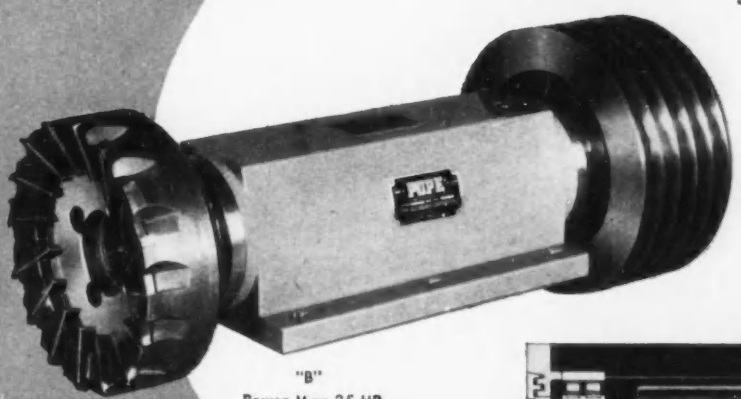
Specify POPE

HEAVY DUTY WHEEL HEADS



"A"

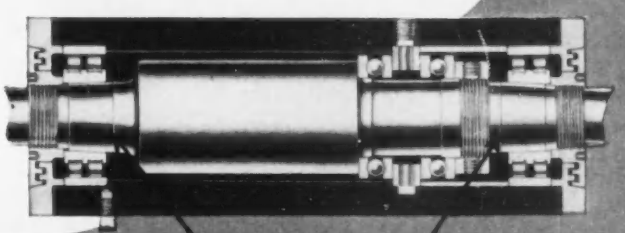


"B"
Power-Max 25 HP

Note the big precision bearings and the big shaft.

A pair of precision thrust bearings stabilize the shaft against any axial movement in either direction. (No end play)

The double row cylindrical roller bearings carry the radial loads with ease and at low temperature.



Taper mounting provides for precise individual preloading of the radial bearings.

Send us your specifications and ask for Catalog No. 59.

POPE Heavy Duty Wheel-Head Spindles are designed for a wide variety of applications such as grinding, boring, milling, drilling and many other operations requiring PRECISION COMBINED WITH RUGGEDNESS in the spindles.

For continuous production and trouble-free operation THERE'S NOTHING LIKE A POPE SPINDLE WITH ROLLER BEARINGS.

No. 94

Specify POPE PRECISION SPINDLES

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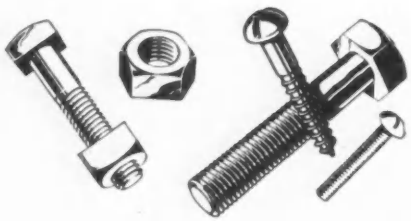
Established 1920

261 RIVER STREET · HAVERHILL, MASSACHUSETTS



Essential to All These Products

You know how essential the right fasteners are to your product. They must be dependable, economical, properly designed and rigidly manufactured to measure up to your own product standards.

In many cases, you can meet every requirement by ordering standard fasteners from the most complete line made for industry, by National.

And, when you need a special fastener . . . there's no problem either when you call on National. For more than 60 years, our reputation has grown and our facilities have expanded . . . because we have been able to answer industry's need for an endless variety of specially engineered headed and threaded products.

With some 3500 producing units, from cold-heading equipment to many types for secondary operation, we offer you experience and facilities second to none. We can tell you how your part can be produced economically and speedily. . . in the volume you need . . . and to the National standards of quality.

For the right fastener, essential to your product, send us your specifications or call your nearest National representative.

THE NATIONAL SCREW & MFG. COMPANY
Cleveland 4, Ohio

Pacific Coast: National Screw & Mfg. Co. of Cal.
3423 South Garfield Ave., Los Angeles 22, Cal.

National PRODUCTS

FASTENERS HODELL CHAINS CHESTER HOISTS

Smoother operating!..

because they have the lowest coefficient of friction of any cylinder

For efficient performance at low pressure, the O-M Cylinder really stands out! Smoothness of bore (4 to 7 micro-inches), and self-adjusting packing reduce friction . . . floating-cushion noses *eliminate binding, dragging, jerking.* This assures a smoother stroke at low or high speeds.

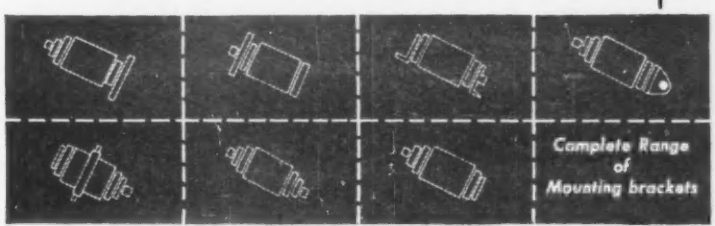
Every O-M Cylinder is All Cylinder! *Interlocking* mechanism does away with projecting tie rods and end caps, saving up to 1/3 installation space, and permitting the use of a more powerful cylinder for the job. Easier to install and repack. End plugs tapped for universal mounting. All machined steel, with bearing bronze (no castings)—easily turned down to fit in deep recesses of machines or bases.

14-DAY DELIVERY ON MOST SIZES

Available in a full range of sizes (1½" to 8" bores) with standard, ⅛ to 1 or oversize rods. Completely interchangeable parts.

O-M air · hydraulic CYLINDERS

Write today for FREE catalog and complete set of ½ and ¼-scale templates showing all cylinders and mounting brackets.



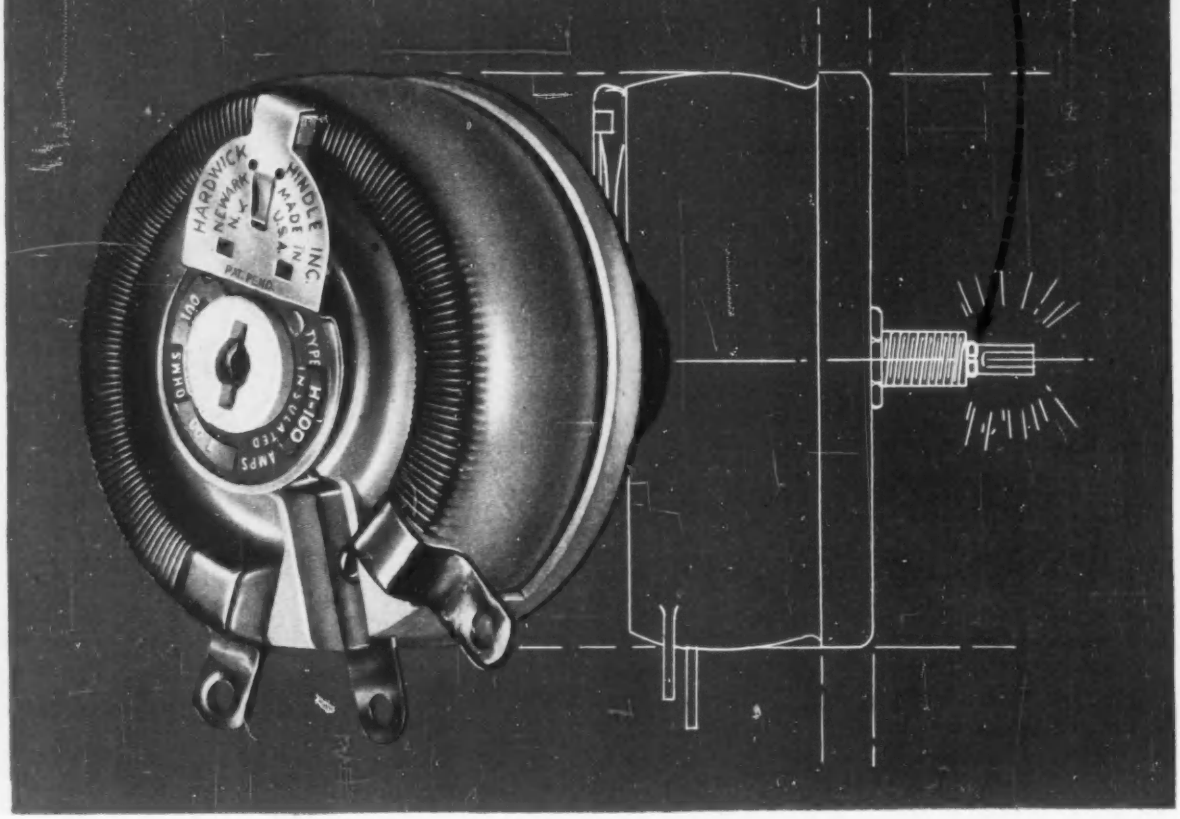
interchangeable bore for bore

ORTMAN-MILLER MACHINE CO.
1218 150th Street, Hammond, Indiana

☐ Please send latest O-M Catalog
☐ Please send Complete Set of Templates

Name..... Position.....
Company.....
Address.....
City..... Zone.... State.....

Let a simple retaining ring save metal and money for you!



Retaining rings saved material and assembly time on this finely made rheostat. They continue to save money both for Hardwick Hindle—the manufacturer—and for its customers.

Looking at this application you may say it was obviously a "natural", but there are literally thousands of cases where retaining rings can save as much or more.

Examine *your* machines and products to see where the use of these inexpensive modern artificial shoulders can cut your costs too.

It is needlessly expensive and wasteful to hold a mechanism in place with unnecessarily big shoulders or collars, or to temporize with small cotter pins etc., etc.

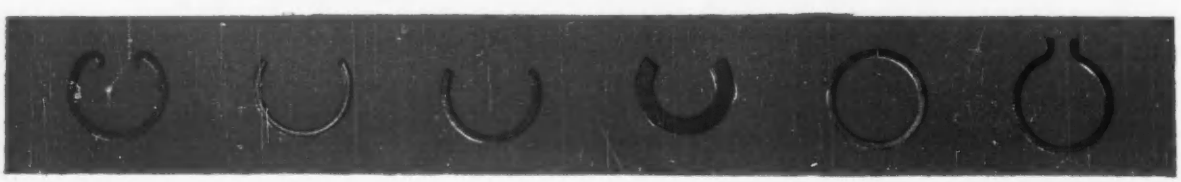
Let us show you how these high grade steel rings can do a thoroughly efficient job, saving money for you as well as for your customers.

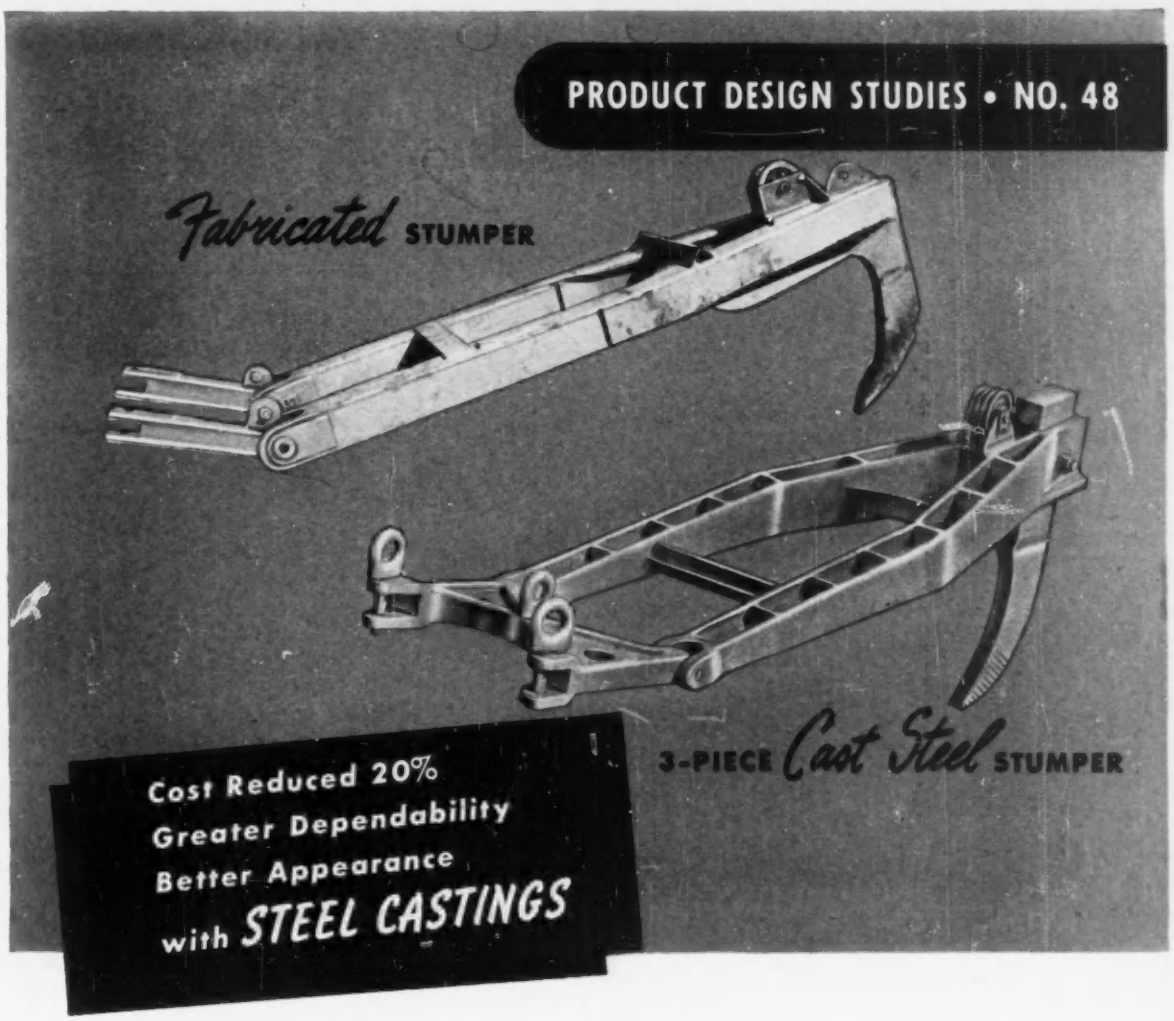
More and more applications of retaining rings are being made every day.

Write today for descriptive folder.

THE NATIONAL LOCK WASHER CO.

NEWARK 5, NEW JERSEY • MILWAUKEE 2, WISCONSIN, U. S. A.





When fabricated—from 39 pieces of steel—this tractor-mounted stumper, weighing more than a ton, lacked the dependability required for its tough job. Furthermore it was too costly. To overcome the service deficiencies would have made the cost even higher.

Conversion to a *foundry engineered* cast steel unit—made up of three separate steel castings—not only produced a tool having the necessary strength and durability, but also reduced the cost approximately 20%. Improved appearance was an additional benefit gained through the use of steel castings.

* * *

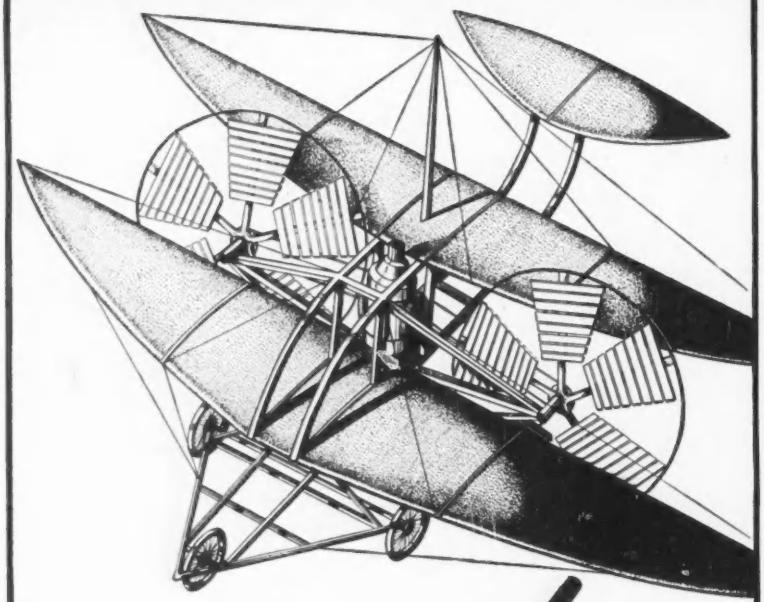
Here is another example of the foundry cooperation which is resulting in lower costs and improved products through redesign to steel castings.

This service is offered without cost or obligation. It makes available through your foundry representative the full results of the development and research program carried on by the Steel Founders' Society of America.

51 YEARS OF SERVICE TO INDUSTRY

STEEL FOUNDERS' SOCIETY OF AMERICA
920 Midland Building Cleveland 15, Ohio

Design and Build With Steel Castings



... out of this came Aviation

...a precision industry

To serve this great industry a manufacturer must maintain the best and most modern equipment available, operate it with skilled craftsmen, and use every existing method of tightening specifications and cutting production costs. Indiana Gear is such a manufacturer—a company of craftsmen producing fine quality transmissions and actuators for industry.

This is the control panel room in I. G. W.'s ultra modern heat-treating department—one of the contributing factors to Indiana Gear's unique ability to create hard-to-make parts to exacting specifications.

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Vellumoid's experience with a wide range of non-metallic materials is at your service. We work to many Government specifications.

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A second yearly compilation of permanently valuable design-engineering data, fully illustrated, from the leading technical magazines published here and abroad.

Product Engineering
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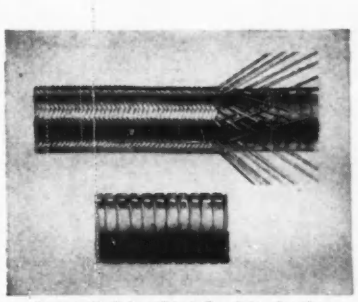
IN NEW CONVAIRS, TOO

Power plant section of Convair 340, one of several Convair types that use Breeze Conduit.

BREEZE MARK

Conduit and Fittings



Breeze Stainless Steel Conduit, showing interlocked and braided construction.

Like so many types and makes of military and commercial aircraft, latest CONVAIRS rely on BREEZE Conduit and Fittings, particularly in the *power plant sections.* In such applications high heat resistance is a critical safety requirement, and BREEZE heat-resistant, stainless steel conduit meets the most exacting specifications in this respect. BREEZE 198 Series Conduit is FIREPROOF —withstands temperatures up to 2000° F. for 5 minutes in accordance with CAA safety regulations, Release No. 259. Breeze Conduit and Fittings for ignition circuits or high tension applications is a production item, readily available in a wide range of sizes. Flexible conduit assemblies are made to specifications for any use.

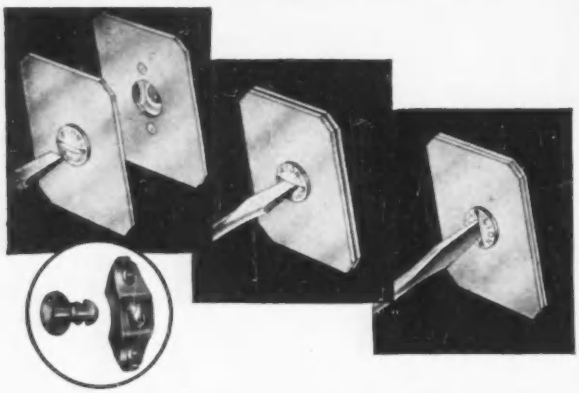
BREEZE FLEXIBLE METAL CONDUIT

CORPORATIONS, INC.

41 South Sixth Street, Newark 7, N. J.

For Parts that must be TAKEN OFF–PUT BACK–BUTTONED TIGHT

LION FASTENERS



LOCKS TIGHT WITH A QUARTER TURN
Always at correct tension

Lion Fasteners are *right* for buttoning parts that must be removed repeatedly for inspection, maintenance, or other reasons.

Vibration and shock can't loosen a Lion Fastener. Even an inexperienced service man can't replace it wrong. A quarter turn opens it. Another quarter turn locks it. The tension is *designed into it.*

Lion Fastener Spring Assembly is quickly spot welded or riveted in place. The stud cannot be lost. It is grommeted tight to the sheet. They will button sheets .040 plus or .020 minus over or under standard rating. The misalignment is as much as .156. The one-piece forged stud is tested to 1425 lbs. Write today for demonstration kit and application data.

TYPICAL APPLICATIONS: INSPECTION PLATES • COWLING • ELECTRICAL PANELS • CABINETS • DUCTWORK

Free DEMONSTRATION KIT contains sample Lion Fasteners to help you visualize their adaptability to your product. Write on your company letterhead. No obligation.

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Diefendorf makes gears on experimental and production contract—of all materials — in all types and sizes. Closest tolerances.

A plant devoted exclusively to custom production. Engineering and design assistance.

DIEFENDORF GEAR CORPORATION
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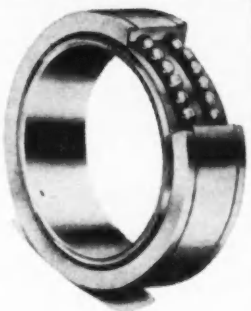
DIEFENDORF GEARS

NEVER BEFORE!!
a
BALL BEARING BUSHING
that:



. . . provides such capacity in such limited space.

. . . improves performance at such a low cost.

. . . extends equipment service life with such savings in weight, space and cost of component parts.

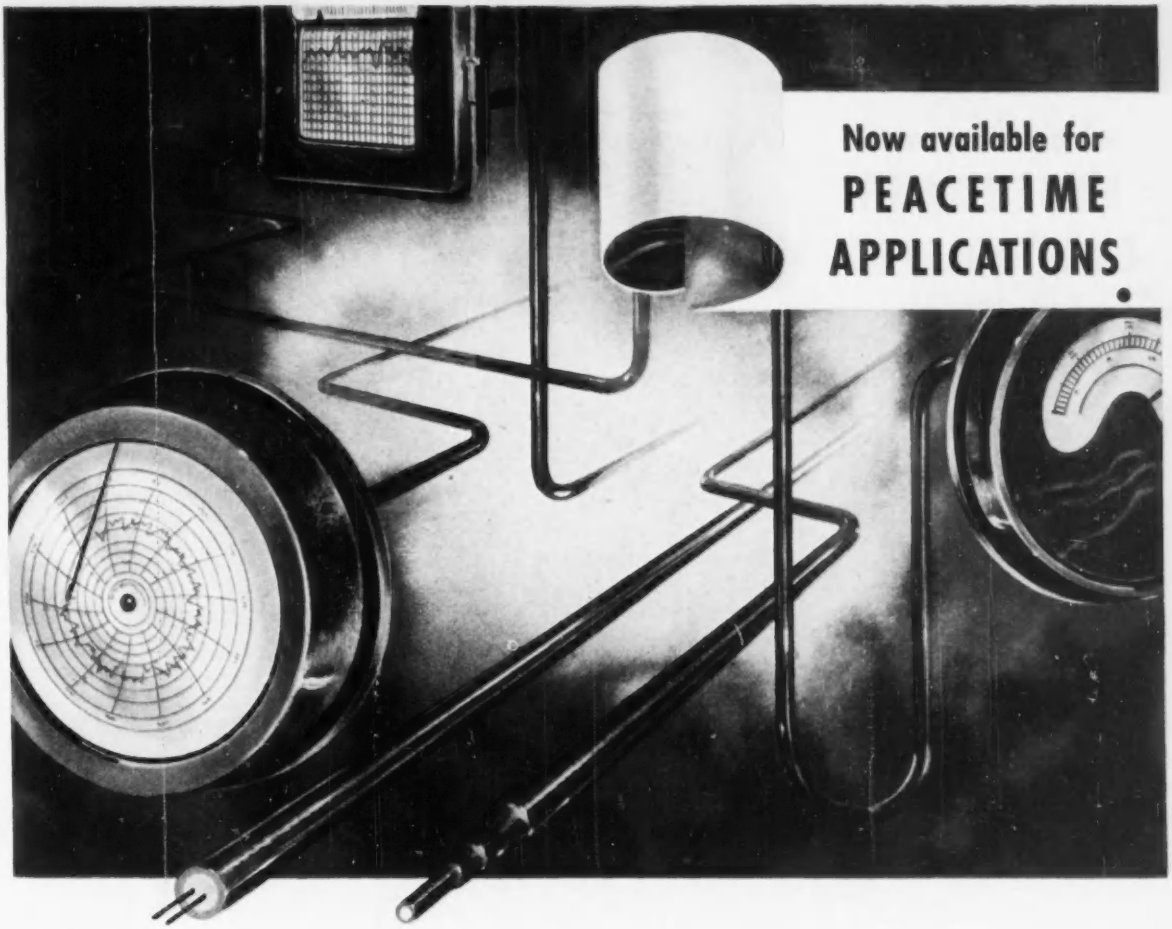
. . . makes so many "impossible" anti-friction bearing applications *possible*, practical and economical.

. . . makes lubrication so much less a problem.

These and other advantages of SPLIT BALL BEARING BUSHINGS are offered for the first time in history. Investigate!

Our Engineering Department is ready always to give you the benefit of its advice and experience.

SPLIT BALLBEARING CORP.
LEBANON 1 NEW HAMPSHIRE



Need to sneak a message through an Inferno?

If you've tried, you know that you need *sheathed* conductors . . . (for the only safe way to carry electrical messages through blistering heat is with wires embedded in magnesium oxide and incased by high heat-resisting alloys).

Now, thanks to research and product development growing out of the *jet engine* program, radically new and superior sheathed conductors are available. Successfully withstanding temperatures up to 1800-2000° F., these have the added advantages of greater rigidity after forming, greater strength, greater resistance to corrosive gases. Equally important, they are fire, water and moistureproof.

We here at Tuttle & Kift are now producing such sheathed conductors in diameters ranging from 1/8" to 7/16" and in lengths up to 20 feet. Both single and two-wire conductors are available—with such material as Chromel-Alumel, Iron-Constantan, copper and aluminum used for the wiring and any one of *ten* or more materials for the outer sheathing.

While, by necessity, most of our production up to this time has been for thermocouple assemblies long approved and specified as standard equipment by jet engine manufacturers, we are now able to offer our facilities and "know-how" to other users. If you have need for such material, we would like to work with you. Simply tell us about your requirements. We'll carry on from there . . . and promptly, too.

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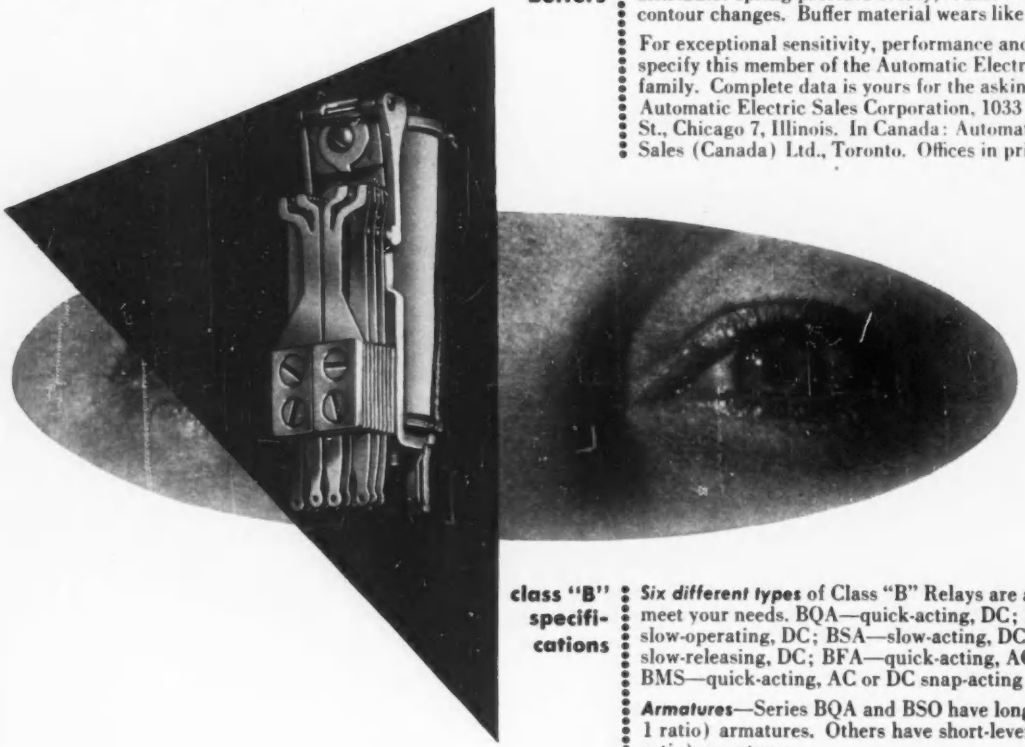
Take a Critical Look Inside...



an Automatic Electric class "B" relay

advanced features

This Class "B" Relay meets stresses at critical areas . . . the stresses and strains of hundreds of millions of operations . . . with advanced features that are standard equipment.

no backstop to wear

The conventional backstop has been eliminated. Working tips of the armature arms rest against non-magnetic discs, spot-welded on the heelpiece at points of contact with the armature, to prevent magnetic "freezing". There is one less part subject to breakage, wear and need for readjustment.

armature "sag off" eliminated

Armature arms are extra-thick, designed to handle any spring load, even under constant, heavy use. There is no "sagging off" or any other such loss of stroke.

pin-type armature bearings

The bearing pin is fixed to the armature, and turns in a yoke with a large bearing surface, packed with solid, long-lasting lubricant. A wear-resisting plate gives the bearing pin a full-length bearing surface. The bearings last and last and *last!* The air-line remains clearly visible, can be checked easily.

wear-resisting buffers

Dome-shape buffer design eliminates "wearing-in", distributes spring pressure evenly, reduces wear and contour changes. Buffer material wears like iron!

For exceptional sensitivity, performance and durability, specify this member of the Automatic Electric relay family. Complete data is yours for the asking. Write: Automatic Electric Sales Corporation, 1033 W. Van Buren St., Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. Offices in principal cities.

class "B" specifications

Six different types of Class "B" Relays are available to meet your needs. BQA—quick-acting, DC; BSO—slow-operating, DC; BSA—slow-acting, DC; BSR—slow-releasing, DC; BFA—quick-acting, AC; and BMS—quick-acting, AC or DC snap-acting contacts.

Armatures—Series BQA and BSO have long-lever (2 to 1 ratio) armatures. Others have short-lever (1 to 1 ratio) armatures.

Contacts—Normally twin. Load carrying capacity, 150 watts (maximum 3 amps.).

Contact spring capacity—Series BQA, BSO and BFA, 13 springs per pile-up. Series BSR and BSA, 6 or more springs per pile-up. Series BMS, 1 or 2 snap-action switches.

Dimensions—Series BQA, BSO, BSA, BSR, and BFA—over-all length, $4\frac{3}{32}$"; width, $1\frac{9}{16}$" to $2\frac{1}{4}$" (depending upon number of springs); height, $1\frac{1}{32}$". Series BMS—over-all length, $4\frac{3}{32}$", width, $1\frac{23}{32}$", height, $2\frac{9}{32}$".

For more detailed information, ask for Circular 1801.

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

BIG CYLINDERS

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From coast to coast, you'll find that most of the special cylinder installations . . the tough jobs that require extra engineering skills and efforts . . are by Lindberg. In a mid-western sheet and tin mill, you'll see Lindberg Cylinders powering a conveyor system. In a southern aluminum plant, you'll see Lindberg Cylinders on aluminum ingot casting equipment. In an eastern steel plant, you'll see Lindberg Cylinders on large materials handling installations.

From out-of-the-way lumber camps in the north woods . . to sprawling textile plants in the southeast . . and busy food processing plants in the west, you'll find that the "special" installations . . the unusual installations . . the difficult-to-design installations are by Lindberg.

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BUMPER FACE-BAR

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High Strength and Impact Resistance with Excellent Cold-Formability

N-A-X HIGH-TENSILE, having 50% greater strength than mild carbon steel, permits the use of thinner sections—resulting in lighter weight of products. It is a low-alloy steel—possessing much greater resistance to corrosion than mild carbon steel, with either painted or unpainted surfaces. Combined with this characteristic, it has high fatigue and toughness values at normal and sub-zero temperatures and the abrasion resistance of a medium high carbon steel—resulting in longer life of products.

N-A-X HIGH-TENSILE, with its higher physical properties, can be readily formed into the most difficult stamped shapes, and its response to welding, by any method, is excellent. Due to its inherently fine grain and higher hardness, it can be ground and polished to a high degree of lustre at lower cost than can mild carbon steel.

Your product can be made lighter in weight . . . to last longer . . . and in some cases be manufactured more economically, when made of N-A-X HIGH-TENSILE steel.

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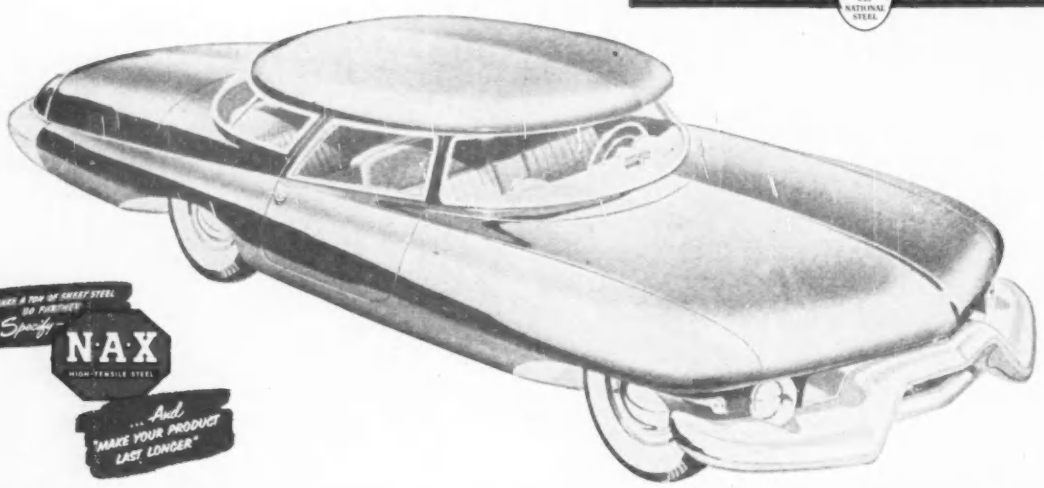
N-A-X Alloy Division — Ecorse, Detroit 29, Mich.

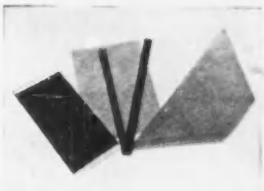
NATIONAL STEEL CORPORATION



MAKES A TON OF SHEET STEEL DO FURTHER!
Specify N·A·X HIGH-TENSILE STEEL
... And "MAKE YOUR PRODUCT LAST LONGER"

KEEP YOUR SCRAP MOVING TO YOUR DEALER

Howell Weather-Protected Motor showing frame construction of 20 h.p. sizes and larger.



Each slot cell has eight pieces of insulation; top and bottom coils and all phase groups are insulated from one another.

Entire stator is twice saturated with resin-based varnish, twice baked at high temperature for complete protection.

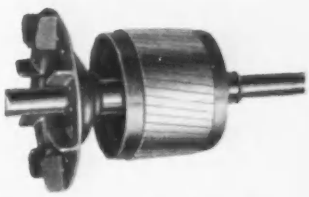
New Howell Weather-Protected Motor!

You can use it on *any* outdoor job—substitute it for *any* standard open motor of the same frame size!

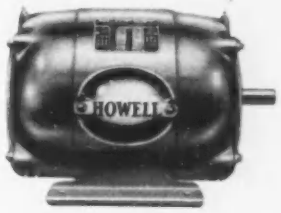
Splashing rain, drifting snow, boiling sun or wind-blown debris can't affect the long life or smooth-running performance of the new Howell Weather-Protected Motor . . . it's designed inside and out for use in *all* kinds of weather!

● Except for ventilation openings, the end plates and heavy-duty frame totally enclose all working parts. Outer surface and hardware are treated to resist rust and corrosion; outer nuts and bolts have hexagonal heads for easy handling. Motor ventilation is obtained from large fans mounted on the rotor shaft which draw air through baffled, screened ventilation openings to cool both windings and stator laminations. The result is a motor ideal for use in the chemical, petroleum or air conditioning industries—anywhere dependable motor performance is required outdoors.

You can get statically and dynamically balanced Howell Weather-Proof Motors in NEMA classifications or special voltages and frequencies, horizontal or vertical mountings, from 1 to 500 h.p. at 1800 rpm; corresponding ratings at other speeds are also available. For further data, or assistance in applying Howell Weather-Protected Motors to your present jobs, call your local Howell representative or mail coupon below!



Copper-clad rotor is fused into an inseparable mass; only copper or copper alloys are used, never aluminum castings.



Frame construction of 15 h.p. Howell Weather-Protected Motors and smaller. Send coupon below for full details on all sizes.

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High Conductivity - Strength - Lightness

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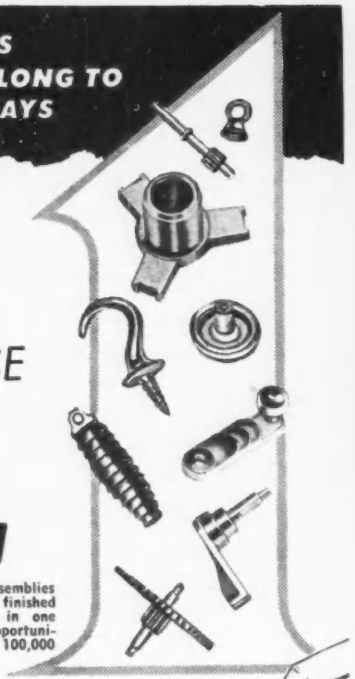
DIE CASTINGS GIVE YOU TINY PARTS LIKE THESE

COMPLETE IN **ONE OPERATION**



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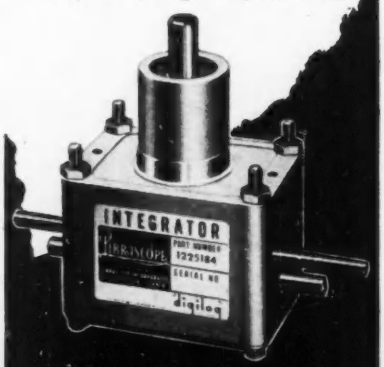
A small size precision integrating mechanism, the Ball-Disc Integrator. Used for totalizing, rate determination, differential analyzing, closed loop mechanical servo-element, and may be applied as a precision variable speed drive or other applications. High performance and long life are assured by the use of super-finished balls and tungsten carbide disc. Size: Width 1⅞", Length 2⅞", Height 3¼", Wt. 21 oz.



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Functional computer components with design emphasis on high performance and simplicity are worthwhile factors to consider when faced with weight, size and reliability restrictions imposed by high precision computer or control problems. Librascope is also well-qualified to investigate your particular system needs.

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Analog and Digital Computers, Input-Output Devices and Components

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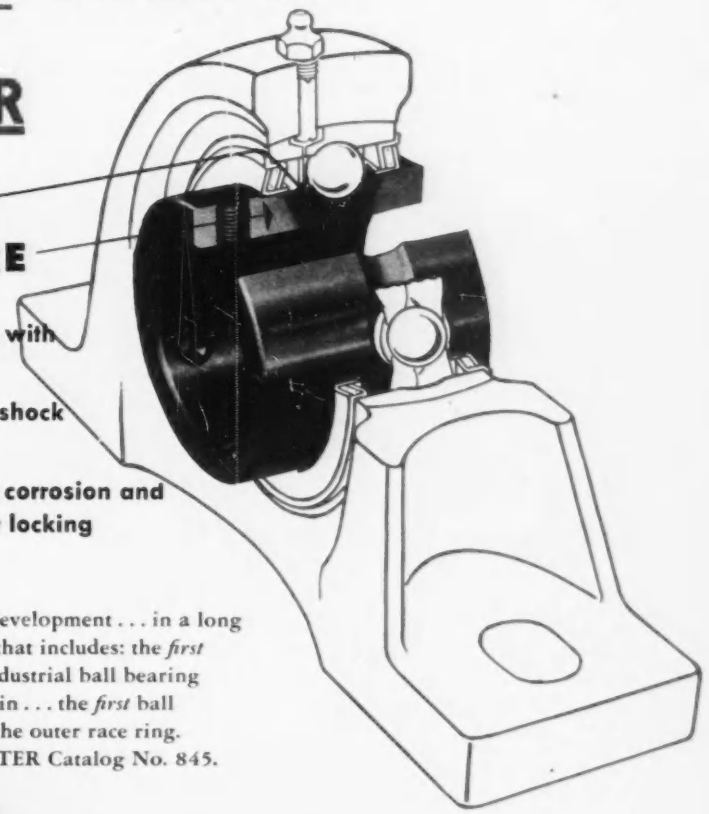
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

ZONE HARDENING*

for MAXIMUM LIFE EXPECTANCY in EVERY BEARING!

Only **SEALMASTER**

is **HARD HERE**
but **SOFT HERE**



- to permit race-to-shaft locking with increased holding power
- to insure greater resistance to shock and vibration
- to minimize danger of fretting corrosion and eliminate shaft wear by firmer locking of bearing to shaft

Zone Hardening is another major development . . . in a long history of SEALMASTER advances that includes: the *first* self-aligning, permanently sealed industrial ball bearing unit . . . the *first* outer race locking pin . . . the *first* ball retainer riding the inner surface of the outer race ring.

Write for your copy of SEALMASTER Catalog No. 845.

ZONE HARDENED
PERMANENTLY SEALED
SELF-ALIGNING • PRE-LUBRICATED
FLOATING BALL RETAINER

***ZONE HARDENING**

is a completely automatic heat treating process by which the inner race ring of SEALMASTER Ball Bearing Units is hardened through ball path section *only*. (See cutaway view.) The extended part of the inner race is left in its original metallurgically soft, tough state. Hardened set screws are mounted through this soft portion, to provide firm race-to-shaft locking and the performance advantages mentioned above. ZONE HARDENING is patented—exclusively SEALMASTER'S!

SEALMASTER BEARINGS

A Division of Stephens-Adamson Mfg. Company
9 Ridgeway Avenue, Aurora, Illinois

FACTORY REPRESENTATIVES AND DEALERS IN ALL PRINCIPAL CITIES

SPECIFY WITH "Confidence"

Morton FIXTURE CLAMPS and FIXTURE DETAILS

SAVES VALUABLE DESIGNING TIME!

Just select the Clamp or Component that fits your need . . . trace into your design. Any MORTON product may be modified to suit your application.

Widest range of sizes and types to fit every requirement.

Immediate Delivery.

Highest quality of workmanship and materials maintained.

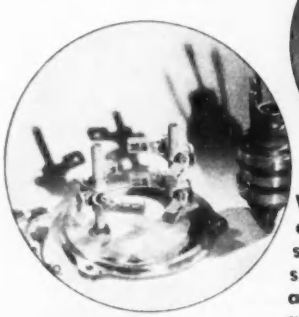
Write Today:

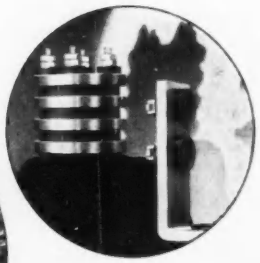
For instructive illustrated catalog containing full size tracing templates of each product, bound in loose leaf style for easy removal.

MORTON MACHINE WORKS

2421 WOLCOTT ST. DETROIT 20, MICH.

Collector Rings

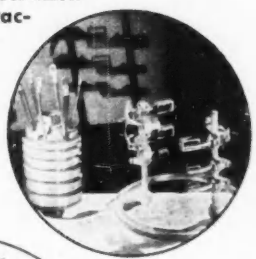


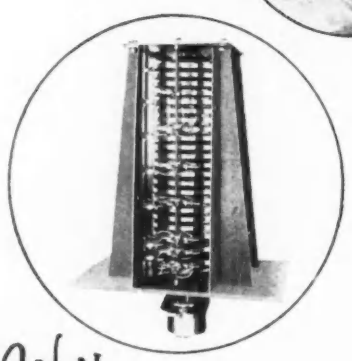


Wesche Collector Rings are available in many standard designs and sizes. More typically, we are called upon to design and build custom rings for a specific application.

Collector rings serve to complete electric circuits between stationary and revolving parts such as heated rolls, revolving platforms or cranes and rotating machine parts. Wesche Rings are bronze, insulated from each other with phenolic or fibre. Required number of terminals extend from one or both ends. Two to more than 40 rings may be assembled into a unit rating from fractional to more than 200 amperes. Up to 48" diameter.

Silver plating, split rings and many other special optional features to order.





Write for catalog containing data sheet for easy ordering.

THE B. A. WESCHE ELECTRIC CO. (Welco)

1624 VINE STREET • CINCINNATI 10, OHIO

Facts about *HELI-COIL* inserts you should know

What they are

*Heli-Coil** screw thread inserts are precision formed coils of stainless steel or phosphor bronze wire. Wound into tapped holes, they form permanent, non-corrosive, strip-proof threads of astonishing strength. Available for National Coarse, National Fine and Unified threads, pipe threads and spark plug threads. They are made in all standard sizes and lengths for assemblies requiring Class 3, 3B, 2 or 2B fits.

What they are for

AS ORIGINAL COMPONENTS: *Heli-Coil* inserts are used to provide stronger, lighter fastenings, corrosion-proof, wear-proof threads in all assemblies.

FOR PRODUCTION SALVAGE: When conventional tapped holes are damaged in production, restore them on the line with *Heli-Coil* inserts. Get better-than-original strength with no increase in screw size and no tell-tale signs of rework.

FOR SPEEDY REPAIRS: When tapped threads wear, strip or corrode in service, renew them in minutes on location in shop or field with *Heli-Coil* inserts. No welding—no plugging—no secondary machining—no oversize screws.

How they work

Holes are drilled and tapped as you do for ordinary threads—then *Heli-Coil* inserts are wound into tapped holes by hand or power tools. Install in a few seconds, assure thread protection forever. Can be used in any metal wood or plastic.

No other method is so simple, effective and practical.

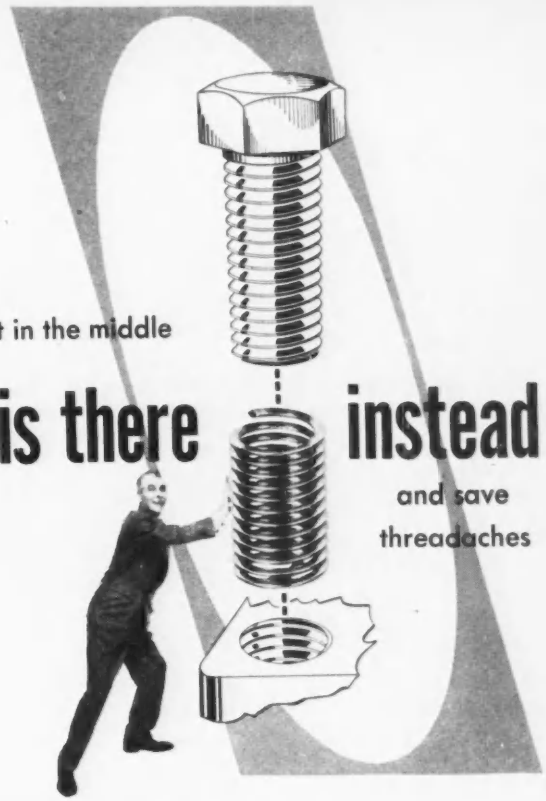
What they do for you

Heli-Coil inserts *save money* because they strengthen threads and make *fewer* smaller fastenings do the same holding job. They make *lighter* bosses and flanges practical and they *save weight* in two ways: (1) by permitting use of cap screws, instead of bolts and nuts; (2) by allowing use of smaller, shorter, fewer cap screws. *Heli-Coil* inserts *protect* your product from thread wear, galling and stripping for life in every kind of metal, in plastics or wood. They preserve customer good-will by preventing product failure, due to thread fault. *Heli-Coil* inserts improve the end product, cut rejects, salvage threading errors.

Best time to put *Heli-Coil* inserts benefits to your use is right at the designing board, as many leading manufacturers are doing. But to convince you of their many advantages ask for a working demonstration right on your production line. Write today! Complete information and engineering data is available in the *Heli-Coil* catalog. Use Coupon!

*Reg. U. S. Pat. Off.

Approved for All Military and Industrial Uses



Don't get caught in the middle

put this there instead

and save threadaches

Sales demanding "twice the product at half the price"? Does production want "half the cost and half the time" on the production line? Where are you? Caught in the middle?

You can be a hero to both sales management *and* production management by telling them about *Heli-Coil** Screw Thread Inserts.

These precision formed inserts of stainless steel or phosphor bronze wire make vastly stronger threads in metal, plastics, and other materials. So much stronger that you can safely use smaller and fewer and shorter cap screws—thinner sections, lighter bosses. Thus costs are reduced, production simplified. And threads cannot strip, corrode or gall—they never wear out.

Learn how other designers are using *Heli-Coil* Screw Thread Inserts. Get the technical data you need to apply them to your "threadaches." Use the coupon—now!

*Reg. U. S. Pat. Off.

HELI-COIL CORPORATION

146 SHELTER ROCK LANE, DANBURY, CONN.

☐ Send Free samples and Handbook No. 652, a complete design manual.

☐ Send Free samples and put me on list to receive "Heli-Call", case history periodical.

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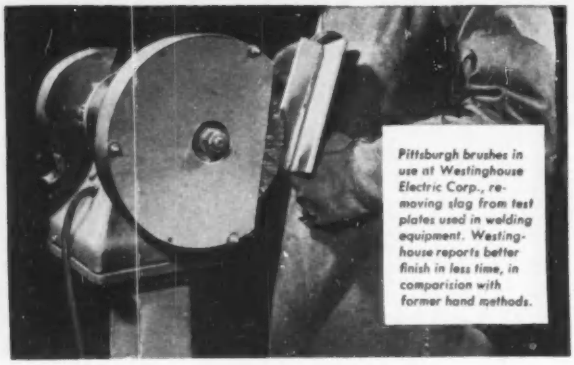


Pittsburgh brushes in use at Westinghouse Electric Corp., removing slag from test plates used in welding equipment. Westinghouse reports better finish in less time, in comparision with former hand methods.

Replace hand finishing with power-driven Pittsburgh Brushes for

Better Cleaning
Lower Labor Costs
Fewer Rejects

—as these companies did:

Removal of imbedded slag in welding test plates formerly was done by hand at the Westinghouse Electric Corp., Trafford, Pa., using a wire brush and welder's hammer. Pittsburgh brushes, powered by a direct-drive ½ h.p. motor, now remove more slag in less time, and produce a better finish. In addition, Westinghouse reports their Pittsburgh brushes "stand up better than average in use."

Complete cleaning of dried concrete, rust and scale from steel frames used in concrete forming is essential prior to re-using the forms. Pittsburgh wire brushes were installed at the Universal Form Clamp Co., Chicago. Working on a conveyor-fed machine, the Pittsburgh brushes now remove all foreign material at a rate of 50 pieces per hour, replacing former laborious hand brushing and scraping.

De-scaling preheated bar stock at the Dominion Forge & Stamping Co., Ltd., Canada, was formerly done by hand scraping. This never did a complete job, and inclusions resulted which produced defective forgings. Pittsburgh brushes, on specially-designed machines, now do the job, and have "increased efficiency, decreased the amount of scrap, improved work quality, and saved labor."

WRITE TODAY FOR FREE BOOKLET!

Write today for a free copy of our booklet that shows, through actual case histories, how Pittsburgh cuts brushing costs. Address: PITTSBURGH PLATE GLASS COMPANY, *Brush Div.*, Dept. W-6, 3221 Frederick Avenue, Baltimore 29, Maryland.

PITTSBURGH

Power Driven

BRUSHES

BRUSHES • PAINTS • GLASS • CHEMICALS • PLASTICS • FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

IN CANADA: CANADIAN PITTSBURGH INDUSTRIES LIMITED

HEINZE BLOWERS

Type F Blowers

Originally designed for cooling electronic tubes in transmitters, induction heaters and diathermy equipment, Heinze F 2 Blowers have become popular also for advertising displays and similar applications where a small current of air and quiet operation are required.

Characterized by low wattage, neat appearance and light weight. The shaded pole motor will not cause radio interference.

F2S

115v AC 60 cycles 15 watts

F2D (double) 20 CFM 3000 RPM (free air)

F2S (single) 10 CFM 3000 RPM (free air)

Heinze Electric Co

685 Lawrence Street, LOWELL, MASS

Engineers

AN INVITATION TO YOU TO GO PLACES WITH FAIRCHILD

Roy W. Lessard, Assistant Chief of Design. Has had extensive aeronautical design and structures experience with many leading aircraft manufacturers and is part of the Fairchild engineering team.

A secure future, exceptional opportunities for advancement, and a high starting salary await you at FAIRCHILD. We have openings right now for qualified engineers and designers in all phases of aircraft manufacturing.

Paid vacations, liberal health and life insurance coverage, 5-day, 40-hour week as a base. Premium is paid when longer work week is scheduled.

ENGINE AND AIRPLANE CORPORATION

FAIRCHILD *Aircraft Division*

HAGERSTOWN, MARYLAND

Direct Hits take Fellows-Cut Instrument Gears by the TON

A typical one of Arma Corporation's automatic aiming mechanisms has some 3,500 gears working in combination. These gears deliver motion only. Excessive pitch line run-out must be avoided or hits become misses.

a fair question

What is the quickest and most economical way to mass produce this accuracy?

Arma has picked the Fellows Method time and time again. Here are 4 reasons why:

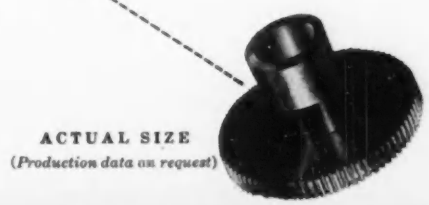
Accuracy—scores of manufacturers in their own field could readily testify to mass production within unusually close tolerances with Fellows equipment.

Speed—a typical gear, shown above, was cut, shaved and inspected in 4 minutes, 40 seconds.

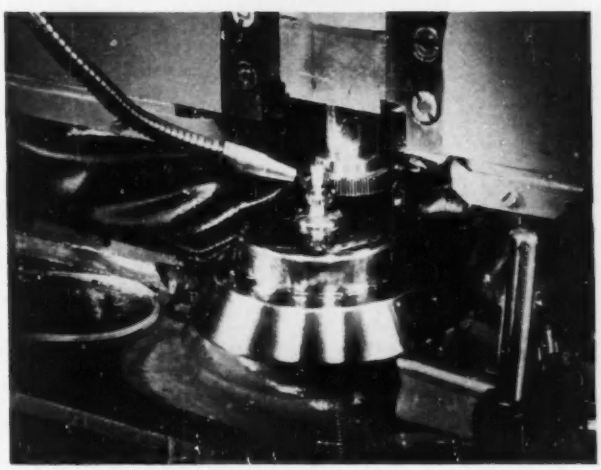
Versatility—the Fellows 3" Gear Shaper cuts gears from 1/16 inch pitch diameter to 3 inch pitch diameter.

Economy—one man runs 3 machines. Easily accessible fixtures cut change-over time.

This is the Fellows Method in action. We would welcome an opportunity to discuss your gearing problems at your convenience.



ACTUAL SIZE
(Production data on request)



FELLOWS CUT . . . by nine 3" Gear Shapers
FELLOWS SHAVED . . . by eight #4 Gear Shavers
FELLOWS CHECKED . . . by four 8M Red Liners

DESIGNERS

Everyone concerned with the design and application of involute gears will want a copy of the latest edition of "The Involute Curve and Involute Gearing." Write the nearest office on your business letterhead.

Fellows

THE FELLOWS GEAR SHAPER COMPANY

Head Office and Export Dept., Springfield, Vermont. Branch Offices: 616 Fisher Bldg., Detroit 2; 5835 West North Ave., Chicago 39; 2206 Empire State Bldg., New York 1, N. Y.

GEAR SHAPERS • SHAVING MACHINES • CUTTERS AND SHAVING TOOLS • GEAR INSPECTION INSTRUMENTS • THREAD GENERATORS • PLASTICS MOLDING MACHINES

HELD IN QUARANTINE

. . . and not released until proved fit!

That's the fate of all PERKINS precision, custom-made GEARS prior to shipment. The folks in our inspection department — a section of which is shown — may be a suspicious lot (never mind what some other people in our plant call them), but when they certify a gear to be sound and "as specified" you can bet your last bottom dollar that the end-product of which they ultimately become an integral part, will be a *better* product!

NOTE 1: A new product is the **Perkins Precision Spring Coiler.** This coiler (patent applied for) turns out precision springs – any type, shape, size, from wire sizes .005 to .125.

2: Another new product – the **Perkins "Bendit 15"** – a patented metal forming machine bends and shapes sheets, rods; strips tubing into innumerable complex as well as simple forms that would be difficult or impossible to make by other means. Eliminates need for expensive tools or specialized skills. Ht. 47", net wt. 200 lbs. Write today for descriptive catalogs, prices etc.

PERKINS MAKES:
Helical Gears
Bevel Gears
Sprockets
Ratchets
Worm Gears
Spiral Gears
Spur Gears with shaved or ground teeth
Ground Thread Worms

PERKINS MACHINE & GEAR COMPANY
WEST SPRINGFIELD, MASSACHUSETTS

Have you

TEMPERATURE PROBLEMS IN BEARING APPLICATIONS?

If you do, you can find real help on this subject—as on so many others—in your *Annual HANDBOOK of Product Design for 1953.* An important, carefully detailed report in the *HANDBOOK* explains an empirical formula which enables the designer to specify speed, load, and lubrication requirements so that the bearing operating temperature will fall within safe limits.

Every new edition of your *Annual HANDBOOK* brings you a wealth of *permanently useful* data representing the significant developments of the year in the field of product-design engineering. This data, painstakingly selected from leading technical publications here and abroad, is specially edited for the *HANDBOOK*—sometimes condensed, sometimes expanded, always fully illustrated by photos, graphs, and charts. The *HANDBOOK* is completely indexed, and sectionalized into ten major classifications for easy reference to subject areas of particular interest to you. The report on operating temperature of bearings mentioned above, for example, is just one of many reports in the sixth section, *Design Analysis and Mechanical Parts,* of the '53 *HANDBOOK.*

In Mid-November, you will receive *The Annual HANDBOOK of Product Design for 1954,* even bigger and more informative than your widely acclaimed *HANDBOOK for 1953.* The new edition will again come to you as part of your regular subscription to *Product Engineering.*

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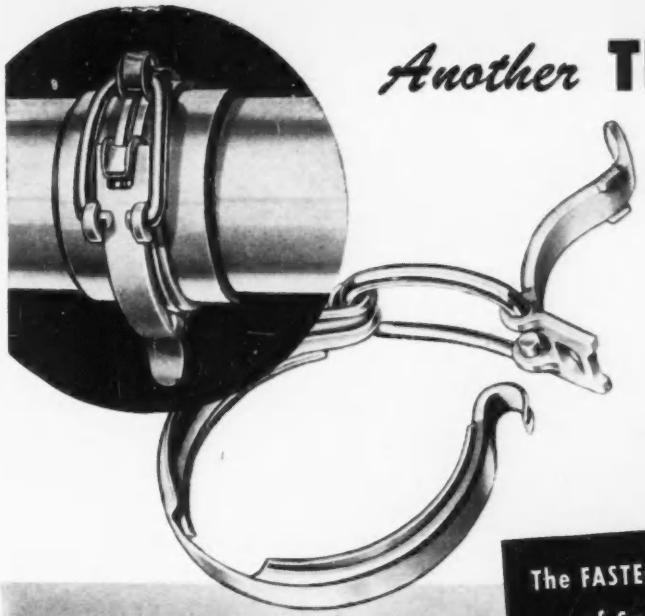


Another **TRI-CLOVER** *First!*

TRI-CLAMP

Snap-action

STAINLESS STEEL SANITARY FITTINGS

The FASTEST, SIMPLEST, MOST ECONOMICAL METHOD of Sanitary Line Installation ever developed

TRI-CLAMP recessless ferrule, showing grooved lip to receive molded gasket.

Special precision molded Hycar gasket provides equal pressure around joint.

TRI-CLAMP positive snap-action spring clamp, with toggle locking device securely attached.

FOR BOTH PERMANENT "C-I-P" AND TAKE-DOWN LINES

At right is the special clamp for use with TRI-CLAMP "Cleaned-In-Place" lines . . . a short toggle clamp which can only be opened through the use of a specially-designed hand tool. This prevents accidental opening or tampering with joints in "C-I-P" sanitary lines and provides a visible means of distinguishing between a "take-down" and "permanent" joint.

In addition to the full new line of TRI-CLAMP fittings, Tri-Clover offers the complete line of standard 3-A sanitary fittings and valves in both stainless steel and Tri-Alloy, utilizing conventional union nut — Acme thread design . . . as well as sanitary centrifugal pumps, stainless steel tubing, Super Speed Tools and manufacturer's specialties. Write for details.

S552

TRI-CLOVER — The leader in the design and fabrication of quality fittings for over 30 years, now presents TRI-CLAMP fittings . . . another "first," making possible an entirely new concept of sanitary line installation.

WHAT IT IS: The TRI-CLAMP Joint consists of a flange type ferrule, precision molded gasket, and the TRI-CLAMP itself . . . a spring clamp which grips ferrule edges with a snap-action toggle assembly . . . always ready for instant assembly or disassembly.

HOW IT WORKS: Attach ferrules to tubing, insert gasket into position, slip TRI-CLAMP over ferrules and gasket and snap closed. Thus, *at a flick of the wrist,* you have completed a positive, sanitary leak-tight joint.

SAVINGS: Substantial savings have been made in initial material cost per joint over conventional union nut ferrule assemblies. When cleaned in place, cleaning cost has been reduced up to 60%.

SIZE RANGE: Available in a full line of fittings for both "permanent" and "take-down" sanitary lines, in 1½", 2", 2½", 3" and 4" sizes in type 304 stainless steel.

See your nearest Tri-Clover Distributor or write for new Catalog 1-152A.

Tri-Clover®

MACHINE CO.

Kenosha, Wisconsin

TRIALLOY AND STAINLESS STEEL SANITARY FITTINGS, VALVES, PUMPS, TUBING, SPECIALTIES

TRI-CLOVER

FABRICATED STAINLESS STEEL INDUSTRIAL FITTINGS AND INDUSTRIAL PUMPS

THE Complete LINE

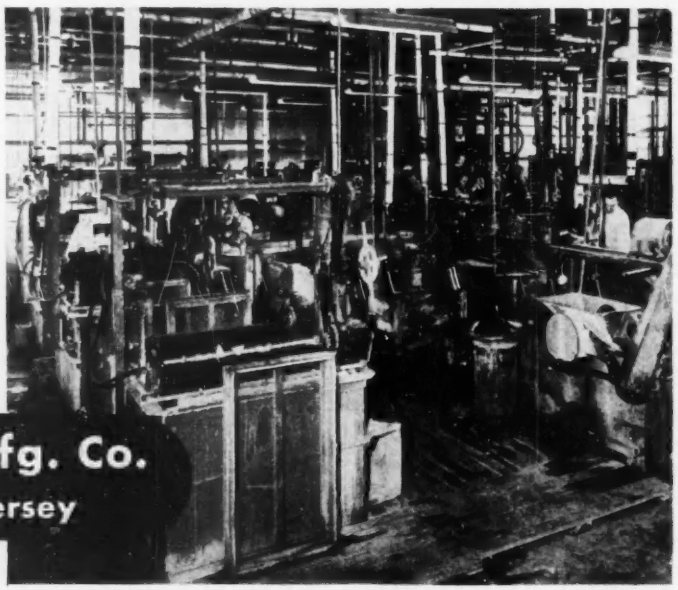
Fire Power...

Product of manufacturing skills

The destructive power and penetrating force of the 3.5" bazooka rocket shown being loaded at left are the end result of design plus skills acquired through manufacturing experience.

Eastern Tool & Mfg. Co. is currently producing precision made wire forms, metal parts and deep-drawings used in the bazooka rocket. Many of these ordnance components receive their final finishing in our large and completely equipped plating and finishing department, a portion of which is shown at the right.

Write for descriptive Booklet No. 100

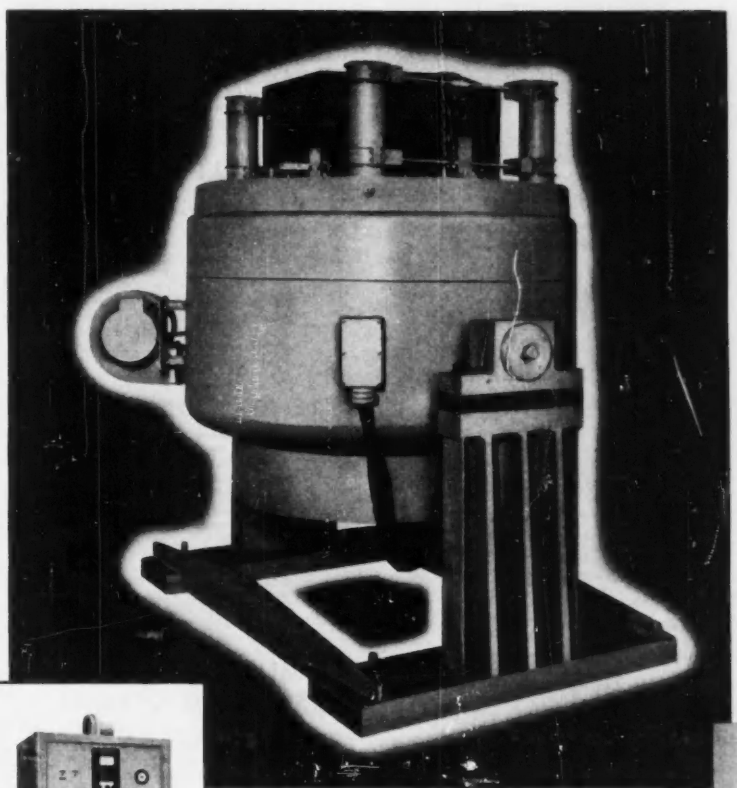


Eastern Tool & Mfg. Co.
Belleville 9, New Jersey

Wire Forming · Metal Stamping · Deep-Drawing

Largest Vibration Exciter Ever Built

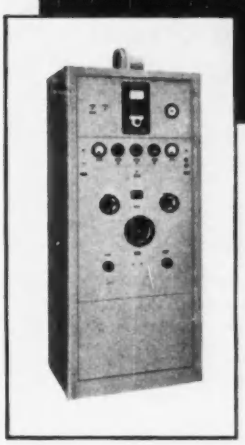
- ***New MB shaker delivers 10,000 pounds force output!***
- ***Widens scope of vibration testing to MIL-E-5272 and other specifications!***



HERE's the latest—and the *largest* — vibration exciter ever built for shake testing. Developed by MB vibration specialists, this unit incorporates all the advances made in the last seven years for assuring dependable operation, pure table motion, and absence of resonances. These include specially designed table flexures, forced air cooling, built in protection against overtravel of the table and against misoperation of the equipment.

This extra heavy duty, conservatively rated, electromagnetic shaker has the capacity and endurance to permit continuous testing at rated output. It will handle anything from electrical components to air-frame structures.

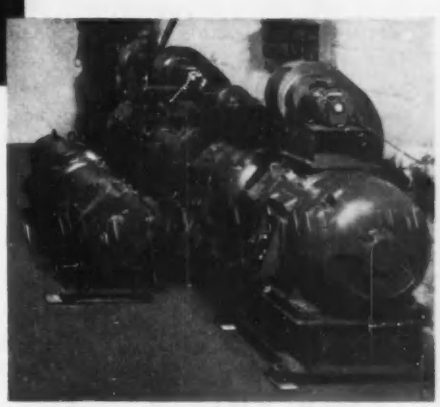
Remember—available MB Vibration Exciters now range from 5 pounds output size all the way up to this new giant. Make MB your headquarters for help on vibration testing and other problems.



MODEL C-100 VIBRATION EXCITER has ½" total table travel. Flexure design supports heavy table loads without sacrificing stroke. Trunnion support permits operation in all positions from horizontal to vertical, and has built-in vibration isolation. Operating range: 5 to 500 cps.

CONTROL PANEL (Model T-100) assures proper operation of equipment with interlocked controls. Accurate, easy, continuous control of force and frequency permits quick adjustments, or "scanning" over entire operating range. MB Vibration Meter provided; also running time meter.

ROTATING POWER SUPPLY rated to deliver full power without need for power factor correction. Blowers cool each unit separately. Alternators feed driver coil of shaker, with minimum harmonic distortion.

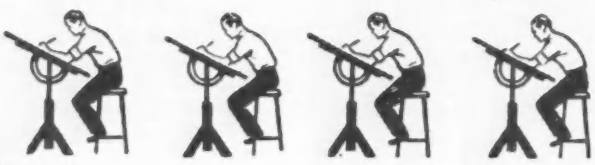


THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

BULLETIN TELLS MORE
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-6.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO GENERATE IT

This Office Typist is doing the work of 4 Draftsmen...



This girl (who doesn't have and doesn't need, an engineering degree) is daily saving her firm the lettering time of 4 draftsmen. And she's doing a neater, sharper, more legible job of lettering, too!

EASY AS ABC to operate! Standard keyboard works like a typewriter. Wide selection of instantly changeable type faces makes Vari-Typer useful and MONEY-SAVING for other jobs.. setting text type for specification sheets, literature, instruction manuals, etc... which can be duplicated on office machines or offset printing.

Vari-Typer Lettering Machine

Body copy produced on DSJ Model.

Headlines photo-composed on the Headliner.

SEND THIS COUPON

...and learn how you too can break that drafting room bottleneck.

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720 Frelinghuysen Ave., Newark 5, N.J.

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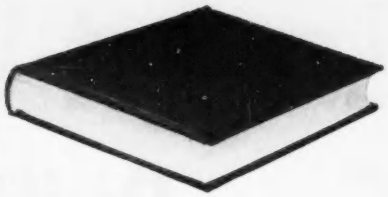

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A simplified quick home-study course in how to figure accurately the effect of stresses and strains upon the strength of materials. Fundamental principles are explained clearly and understandably. Gives numerous fully worked out problems. Topics covered include tension and compression, riveted joints, welded connections, beam and column design, beam deflection, and many more. **By John W. Breneman, Assoc. Prof. of Engin. Mech., Penn. State Col. 2nd Ed., 140 pp., 145 illus., $3.00**

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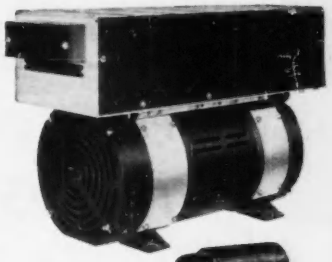
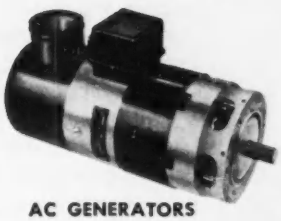
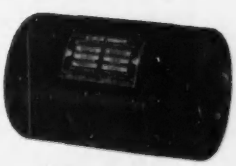


INVERTERS



AC GENERATORS

SPECIAL-PURPOSE ELECTRON TUBES

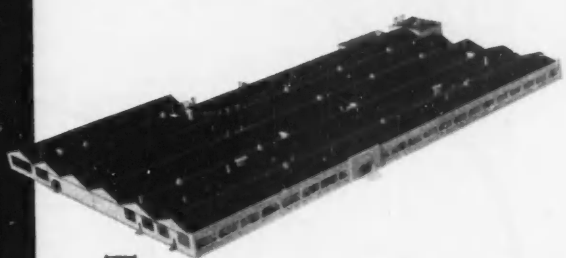


DYNAMOTORS

Bendix Aviation Corporation

concentrates development, sales and production of special-purpose electron tubes, inverters and AC generators with its dynamotors and small motors at its

Red Bank Division



To provide its customers with an unequalled source for special-purpose electron tubes, inverters and AC generators, Bendix Aviation Corporation has placed its entire development, sales and manufacture of these products with its Red Bank Division at Eatontown, N. J. Here in a modern new plant of over 118,000 square feet have been concentrated the most highly skilled personnel and the latest available machinery to produce the highest quality electron tubes, inverters and AC generators possible. At the same time, a full-scale program is being carried on continuously at Red Bank to develop these products for even greater efficiency and versatility. In addition to its new products . . . taken over from the Eclipse-Pioneer Division, Teterboro, N. J. . . . the Bendix Red Bank Division will continue producing its established line of dynamotors and small DC motors. If you require precision items of these types, it will pay you to take advantage of the unique experience and facilities offered to you by Bendix Red Bank.

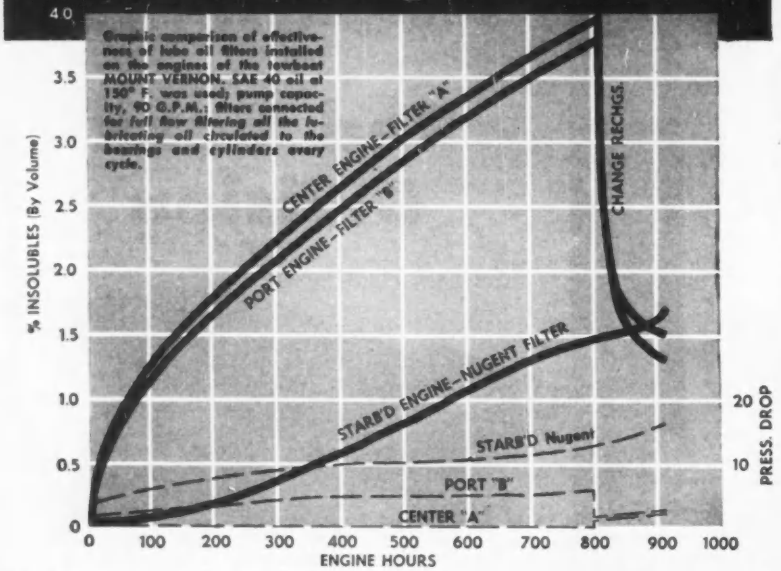
Division of Bendix Aviation Corporation — THE NAME MILLIONS TRUST

Bendix Red Bank

EATONTOWN, NEW JERSEY

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

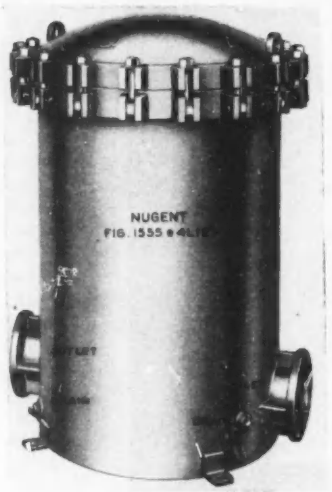
Side-by-side Comparison under operating conditions proves the superiority of NUGENT Filters



IN order to unquestionably determine the relative effectiveness of three leading lube oil filters, the owners of the towboat, MOUNT VERNON, installed a different make of filter on each of the boat's three identical engines. At regular intervals for 800 engine hours, the cleanliness of the oil was checked and recorded. The graph above shows the results—at the end of 800 hours the oil that was Nugent filtered contained less than half the concentration of insolubles as the more effective of the other two filters. Note, too, that oil passing through the other two filters was dirtier in 200 hours than the Nugent filtered oil was at the end of 800 hours.

Nugent filtering will give you this effectiveness, too. It will add to the life of your engines by reducing the amount of harmful impurities that reach vital working parts. It will extend the life of lube oil by keeping it cleaner longer.

For full information on how Nugent filtering can help you, write, outlining your filtering problem. Descriptive literature on Nugent filters is also available on request.



Nugent filter of the type used in the test aboard the MOUNT VERNON.

Wm. W. Nugent & Co., Inc.
441 N. Hermitage Ave. CHICAGO 22, ILLINOIS

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Established 1897

The Annual HANDBOOK of Product Design for 1954 is in production

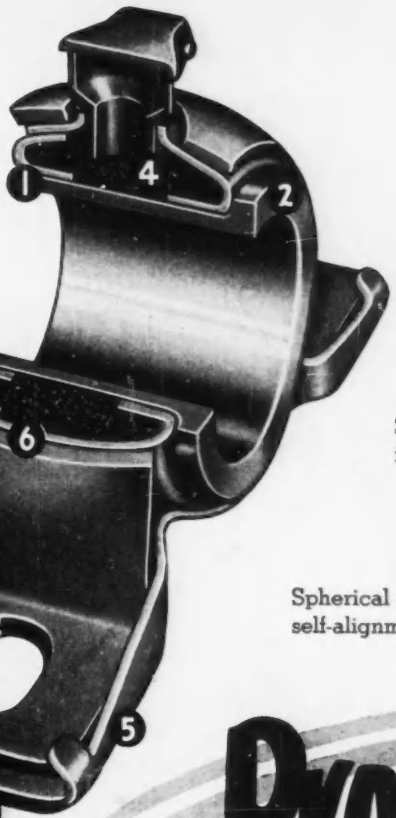
The Annual HANDBOOK of Product Design for 1954 will be ready in Mid-November. Our special *HANDBOOK* editorial staff, with the full cooperation of all other *Product Engineering* editors, is hard at work on the year-long job of selecting the most significant design-engineering data that is being published in the world's technical press this year.

Indications are that this year's edition of the *HANDBOOK* will be even bigger and more helpful to you than the *1953 HANDBOOK* about which we are receiving so many enthusiastic comments from product-design engineers everywhere.

As before, all editorial material, and related advertisements, will be grouped into ten separate sections, enabling you to locate the information you want on any specific subject quickly. Both the editorial and advertising pages will be thoroughly indexed and, in addition, the 1954 edition will carry a complete editorial index of the *1953 HANDBOOK*.

Again this year, the *HANDBOOK* will come to you as part of your regular subscription to *Product Engineering*.

Product Engineering
330 West 42nd St.
New York 36, N. Y.



1 Self-oiling composition bushing feeds oil to shaft by capillary action.

2 Bushing has shoulder which provides self-lubricating bearing surface for collar.

3 Slotted Bolt Holes. Rubber grommets can be used for sound isolation.

4 Absorbent filler holds oil in reservoir and prevents over-lubrication.

5 Split Pressed Steel Housing is light and strong.

6 Spherical surfaces provide full self-alignment.

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Bronzoil

FAN AND BLOWER BEARINGS

Proved

in Millions of installations!

Engineered to meet the specialized requirements of fan and blower service, Dodge Bronzoil bearings are widely and successfully used on small shafts for general service, within the limits of their capacity. Capillary bronze bushing has a capacity of one-third its volume in oil. The liberal oil reservoir, with close fitting wick, surrounding the bushing provides ample lubrication. Millions of Bronzoil bearings have proved their dependability through years of service. Available in shaft sizes from 3/4" to 1 1/4". Write now for literature and detailed information.

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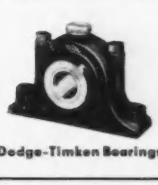
DODGE

of Mishawaka, Ind.

1878 DODGE 1953 75th ANNIVERSARY

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory-trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone book.



Dodge-Timken Bearings

Taper-Lock Sheaves

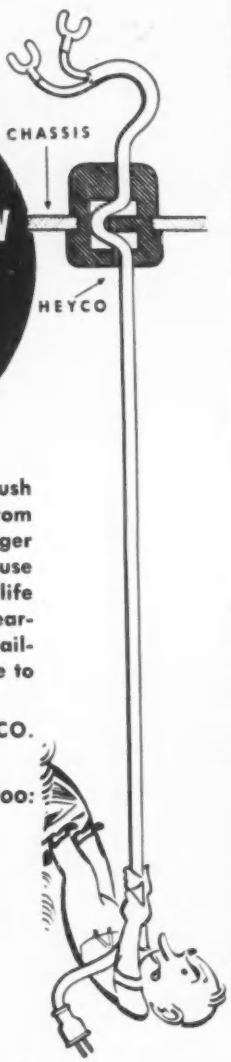
Sealed-Life V-Belts

[redacted]

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, CHICAGO THRIFT-ETCHING CORPORATION, 1200 N. SHEFFIELD AVENUE, CHICAGO 22, ILLINOIS

HEYCO Nylon Strain Relief Bushings cut production costs and improve product quality!

Facts you should know about HEYCO Strain Reliefs



Heycos absorb all cord pull, push and torque and insulate wire from housing. With Heycos it's no longer necessary to tie wire knots or use insulating grommets. Product life is increased and product appearance is greatly improved. Available in all sizes from clock wire to S-10/3 cable.

HEYMAN MANUFACTURING CO.
KENILWORTH 3, NEW JERSEY

It's easy to apply Heycos, too:

1. *Slip over wire*
2. *Snap into hole*

FULLY APPROVED BY
Underwriters' Labcratories and Canadian Standards Asso.

HEYCOS positively eliminate strain on terminals!

Send for Samples and Specifications

HEYCO

For Double Protection Use Approved HEYCO Strain Relief Bushings

FUNK *Special*

POWER UNIT CLUTCHES *and* TAKE-OFFS

This right angle drive and heavy-duty clutch unit is only one of many engineered and manufactured by FUNK. There are types and styles to fit almost any requirement for shaft speed and installation space. They are designed to fit any standard SAE flywheel housing or Ford Industrial Engine. Our engineers will be glad to work with you on any special power problem.

FUNK Products include:

- Straight Power Take-Off Clutches
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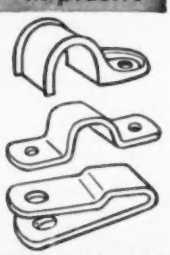
- Ford Tractor Conversion Kit, changes to 6 or V-8 engines, doubles the power at 1/3 the cost.

FUNK AIRCRAFT CO.
3301 Airport Drive Coffeyville, Kansas

TOUGH . . . Enduring



Safer, Simpler, faster, more secure. For cables, thin-wall tubing, wires, conduits, light hose. *No shorts! No tearing! No corrosion!* Wide variety shapes, styles, sizes and materials. Write today:

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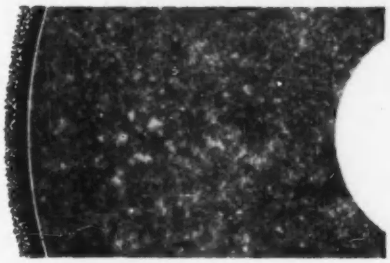
PLASTICS CO.

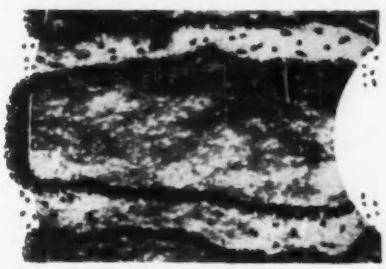
GRADUATED DENSITY

makes MICRO-KLEAN the most effective filter on the market!

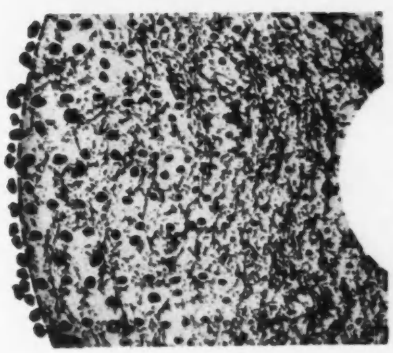
How MICRO-KLEAN compares with other cartridge filters



Compare MICRO-KLEAN with FILTERS WITH THE SAME DENSITY THROUGHOUT. The filter media density is the same on the pressure and discharge surfaces of the element; therefore, dirt accumulation is largely on the outside surface, choking the cartridge ("plastering") and reducing the effective filter life.



Compare MICRO-KLEAN with FILTERS WITH HAPHAZARD DISTRIBUTION OF FILTER MEDIA. Uneven haphazard media density permits fluid to find channels through the filter, and pass solids larger than the minimum filter spacing.



Now Look at the advantages offered by MICRO-KLEAN. See how the fibre density increases toward the discharge side of the MICRO-KLEAN filter cartridge? In effect, every Cuno MICRO-KLEAN cartridge is an infinite multiplicity of screens, ranging from relatively coarse on the outside down to 10 microns in the center. Because of MICRO-KLEAN's graduated density in depth, particles are entrapped within the entire depth of the filter element, giving the cartridge a much longer effective life. Standard cartridge size is 9¾" long by 2¾" O. D., in densities of 10, 25 and 50 microns.

MICRO-KLEAN gives you

- greater dirt holding capacity
- absolute protection against rupturing or channeling of the cartridge
- longer effective cartridge life

REMEMBER . . . IF YOU CAN PUMP IT, CUNO CAN FILTER IT

M.3.C

CUNO **ENGINEERED FILTRATION**
Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (disc-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound)

COMPACT FILTRATION OF LUBE OILS, HYDRAULIC FLUIDS, AND COOLANTS

Fewer Cartridge Changes Necessary with MICRO-KLEAN Filters

You don't need a complicated, bulky filter to keep dirt and abrasives out of your lube oils, hydraulic fluids and coolants. Cuno's compact MICRO-KLEAN cartridge is all filter, with no space-consuming structural members to offer resistance to flow.

The high porosity and low pressure drop operation of MICRO-KLEAN filters permit full-flow service on gravity, low pressure, or suction lines—with no loss in operating efficiency.

Cartridge replacement costs are generally cut in half when MICRO-KLEANS are used. MICRO-KLEAN's graduated density in depth provides much greater capacity for dirt accumulation within the micronic cartridge, giving twice the useful life of an ordinary filter element. The specially engineered construction of MICRO-KLEAN affords simplicity of installation and maintenance. Changing cartridges can be accomplished in a few seconds—only one nut has to be removed.

Send for Cuno's free filtration analysis form, have one of your engineers fill it out, and mail it to us. We'll let you know exactly what you need for your filtration requirements—without obligation. And take advantage of Cuno's unique "money-back" offer: if MICRO-KLEAN doesn't outperform any filter cartridge you have previously used, we'll send you double your money back. So send the coupon today for free MICRO-KLEAN bulletin. M.3.4

Cuno Engineering Corporation
Dept. 304C South Vine Street, Meriden, Conn.

I'm interested in your "money-back" offer. Please send me your filtration analysis form—and more information on MICRO-KLEAN for

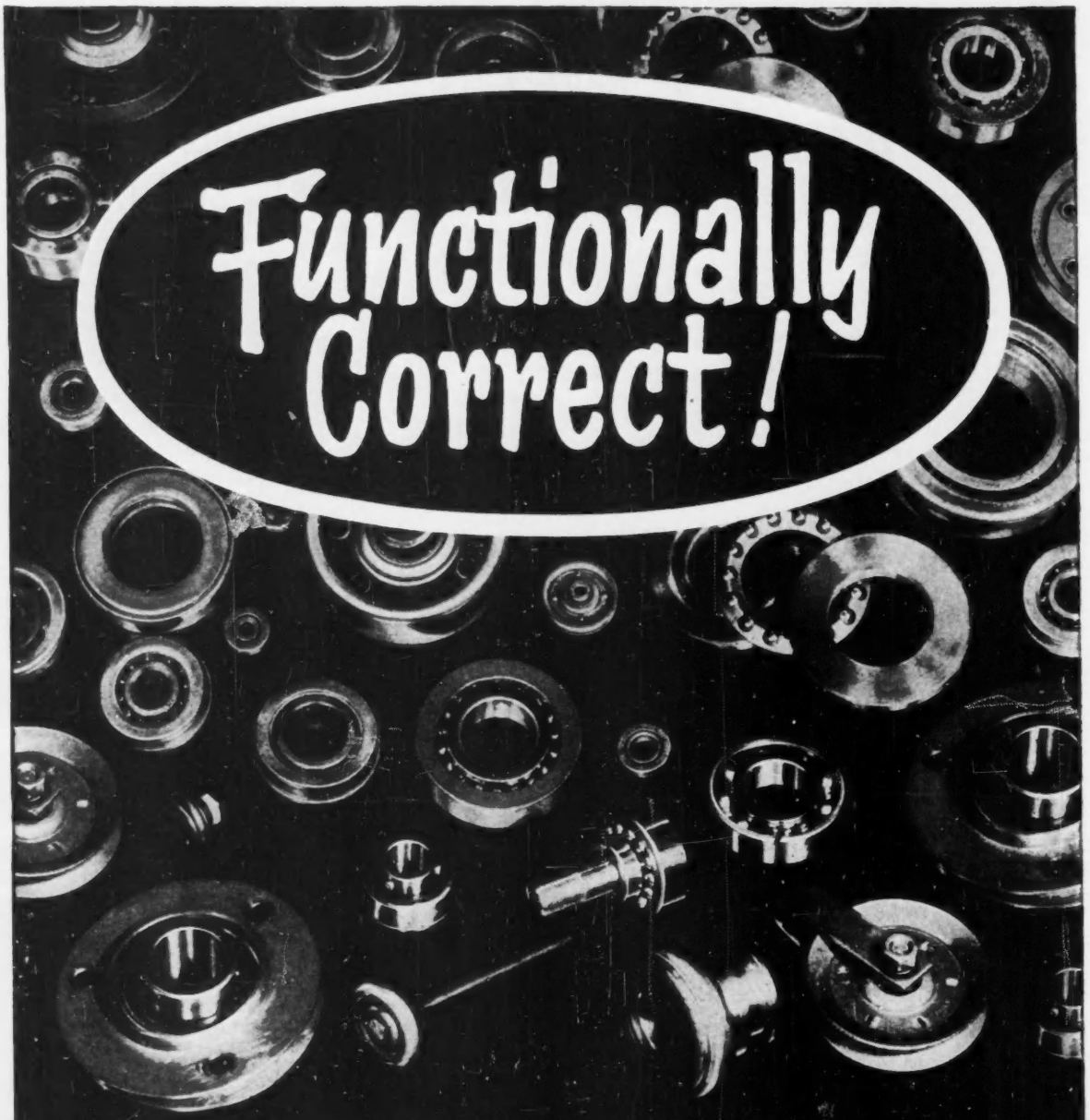
..... (fluid)

Name.....

Company.....

Address.....

City.....Zone....State.....



In product design, FUNCTIONALLY CORRECT means *exactly right* for the job, not more, nor less. Beyond a reasonable safety factor "over-engineering" in the form of excessive capacity, unnecessary precision or unwarranted expensive materials may lead to commercial failure; every component part must be designed or selected to be functionally correct at minimum cost.

NICE BALL BEARING COMPANY produces complete lines of precision, semi-precision and unground standard and special bearings. Hence, NICE field and factory engineers offer the advantage of a diversified product and experience . . . and are well qualified to recommend or design the economically and functionally correct bearing for your particular application.

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time delay relays...

PROVIDE YOU WITH POSITIVE CONTROL FOR VITAL PROCESSES AND EQUIPMENT

Accurate, dependable timing is essential to insure the performance of your product . . . to speed up operations to maximum efficiency . . . to prevent work spoilage and to protect vital processes and equipment. Whatever the application, play it safe by specifying Cramer.

TYPE TEC

High accuracy timer, designed to provide an adjustable time delay between the closing of a control circuit and the subsequent closing or opening of a load circuit.

OUTSTANDING FEATURES

- **ACCURATE** . . . Repeat accuracy ½ of 1% of full scale reading. Overall accuracy (inclusive of setting), 2%.
- **EASY TO SET** . . . Micrometer adjusting knob insures extremely precise setting, yet can be set rapidly. Separate progress pointer indicates unexpired time.
- **EASY MOUNTING** . . . Convenient one-hole, meter-type mounting. Designed to blend well with your machine.
- **POSITIVE CLUTCH** . . . Serrated face-plate clutch insures positive engagement. No friction element to slip or wear.
- **TOTALLY ENCLOSED SWITCH** . . . Quick-make, quick-break, snap-type. Handles 10 amps. non-inductive at 110 volts A.C.
- **EXTRA STRENGTH MOTOR** . . . High torque Cramer motor provides extra reserve strength for adverse operating conditions.

the R.W. CRAMER CO., INC.

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Interval Timers — Time Delay Relays — Time Totalizers — Cycle Timers — Running Time Meters — Pulse Timers — Hermetically Sealed Military Timers — Synchronous Timing Motors — Reset Timers — Duplex Cycle Timers — Percentage Timers — Clutch Type Motors — Multi-Contact Timers — Chart Drive Motors — Intervalometers

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with scientific accuracy

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Technical Data Sheet

Without obligation, write for our informative new Data Sheet which details fully the advanced Technic Inc. gold plating methods and services for platers outlined above.

For reference, you will also receive a list of leading industrial concerns — many with production problems resembling your own — which rely on Technic Inc. controlled gold plating installations to improve production while reducing cost.

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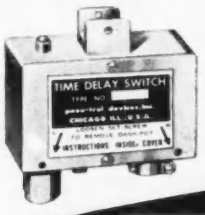
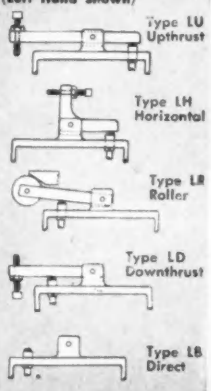
THE LARGEST ENTERPRISE OF ITS KIND IN THE WORLD

NEW CYLINDER TIME DELAY CONTROL SWITCH

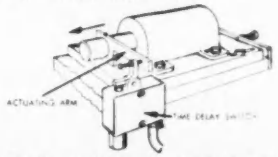
INCREASES APPLICATION . . . WIDENS USE OF CYLINDER POWER



For Any Type Actuation Left or Right Hand (Left Hand Shown)



Pneu-Trol Time Delay Switches provide independent hydraulically controlled adjustable time dwell between ¼ and 60 seconds in 20 to 1 ratios. Readily mounted on machine for cylinder dwell at a positive stop. Compactly designed—a simplified low cost answer to electrical time dwell control of any air or hydraulically operated machine movement such as press work, burnishing, coating, quenching, metal-cutting, etc. Ideal for automatic feeders.
Dimensions: 4⅛" wide; 2⅜" high; 1-7/16" deep. Overall height 4⅛".



SWITCH MOUNTED TO PROVIDE DWELL AT END OF POWER STROKE

Write for descriptive literature and complete details.

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Design Your Own Precision Gaging Fixtures

. . . around this Inexpensive Gage Head Cartridge

Measures by .0001" —.00001"

Compact, shock-proof, and moisture-proof, this Brown & Sharpe Gage Head Cartridge No. 953 gives you a simple means for designing high precision into your own gaging fixtures.

Readings in .0001" to .00001" are taken on the No. 950 Electronic Amplifier. Simply plug the cartridge into the amplifier. You take readings directly from the amplifier's accurately graduated dial . . . only one master required for setting. And you can design cartridges into several fixtures and use the same amplifier on all of them.

The unique design of the cartridge provides simple adjustment, frictionless movement, adjustable measuring pressure, and wide adaptability to many inspection devices, jigs, fixtures, and machines. Write for detailed Bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

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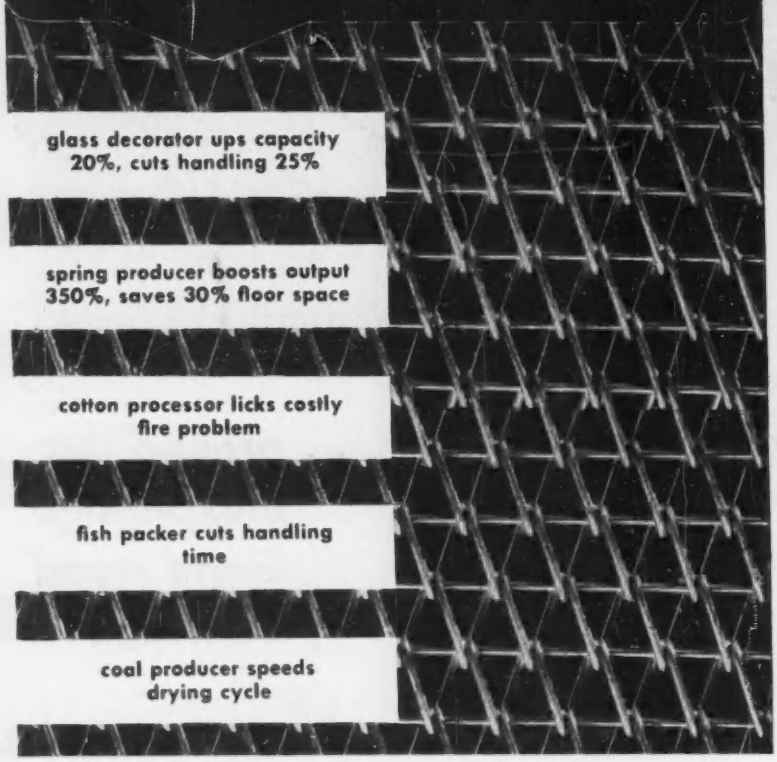
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Cambridge Wire Mesh Conveyor Belts

have helped produce these cost-saving results in plant after plant across the nation.

Wouldn't it be a good idea for you to investigate how these amazingly versatile conveyor belts can combine movement with processing in the equipment you are building?

They can be used at temperatures ranging from sub-freezing for food packers, to as high as 2100° F. for heat treating. They can be used in corrosive solutions such as pickling acids or in ordinary water if your product must be washed during processing. Open mesh of the belt allows free circulation of process atmospheres, free drainage of process solutions. All-metal construction means long life and low maintenance. They're available in any metal or alloy, mesh or weave, length or width.

Best of all, Cambridge has a solidly experienced Field Engineering staff at your service. Look under "Belting-Mechanical" in your classified telephone book for the man nearest you. Call him in at any time.

Incidentally, we'll be glad to send you details on any of the result stories described in the heading of this advertisement.

FREE, FOR YOUR OWN STUDY —NEW, 140 page Cambridge Belt Catalog illustrates and describes wire mesh belt specifications, gives conveyor design sketches and metallurgical data. It's a must-reading for economy minded designers! Write for yours!

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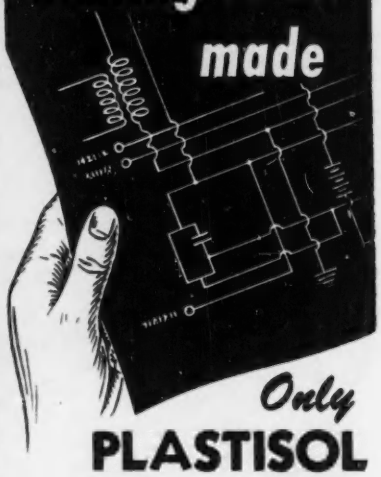

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Industrial Coatings

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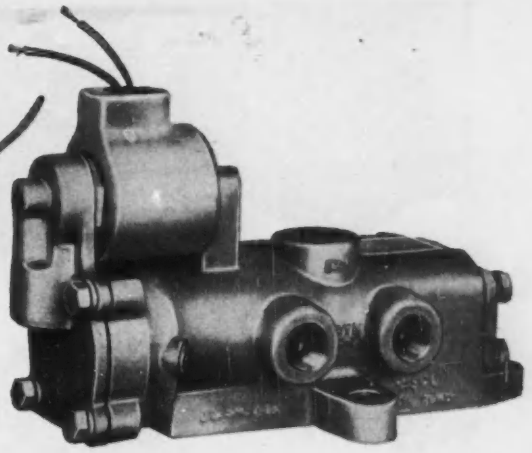
High Speed Solenoid Valve
Produced by ASCO



Headquarters for Solenoid Valves and Electromagnetic Controls

Type — 4 Way Valve, Screwed Pipe Connections or Manifold Mounting. Available for 5 ported operation and regulated flow control.

Use — Controlling Ultra High Speed Double Acting Pneumatic or Hydraulic Cylinders.

Operating Speed with Air, 500 Cycles/Minute Continuous; 750 Cycles/Minute Intermittent.

Design Features

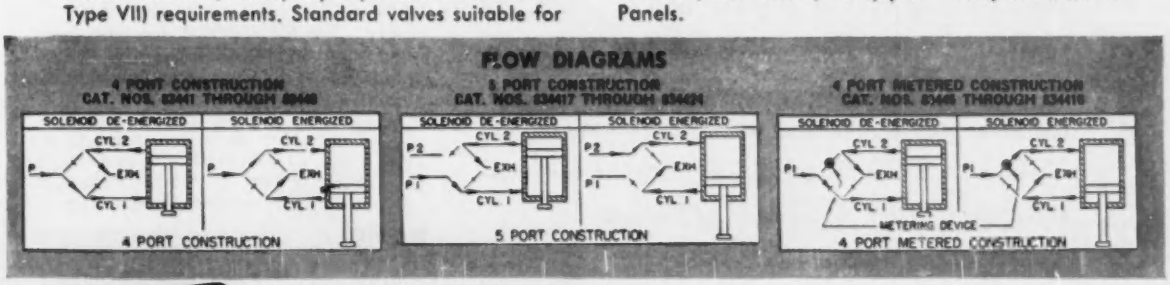
- **Instantaneous Action.**
- **Poppets on Common Shaft operated by line pressure inherently provide simultaneous valve action and tight seating.**
- **Differential Piston provides power operation in both directions. Eliminates all danger from sticking.**
- **Short Strokes; Guided Inserted Seats; Minimum Wear.**
- **Packless Construction—No Stuffing Boxes or Sliding Glands.**

This Solenoid Valve has been thoroughly tested at High Speed for millions of operations.

This Valve (Bulletin 8344) comes with mill type construction, corrosion-resistant bronze body and stainless steel seats and discs. Four standard sizes are available; ⅜, ½, ¾, and 1 inch. The compactness of the Valve is indicated by the dimensions of the largest (1 inch) unit; length 11½ inches, width 5⅜ inches, height 5 1/16 inches. The standard solenoid is suitable for NEMA Type IV Watertight and for Underwriters' Class 1, Group D, Explosion-Proof (NEMA Type VII) requirements. Standard valves suitable for pressures up to 250 psi, may be adapted to higher pressures, if required.

In writing for prices, delivery, and other information, tell us about your control problem. We have many other varieties of standard Solenoid Valves, and engineering facilities for designing special types should you need them.

We manufacture a complete line of standard and specialized Electromagnetic Controls. These include Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and complete Control Panels.



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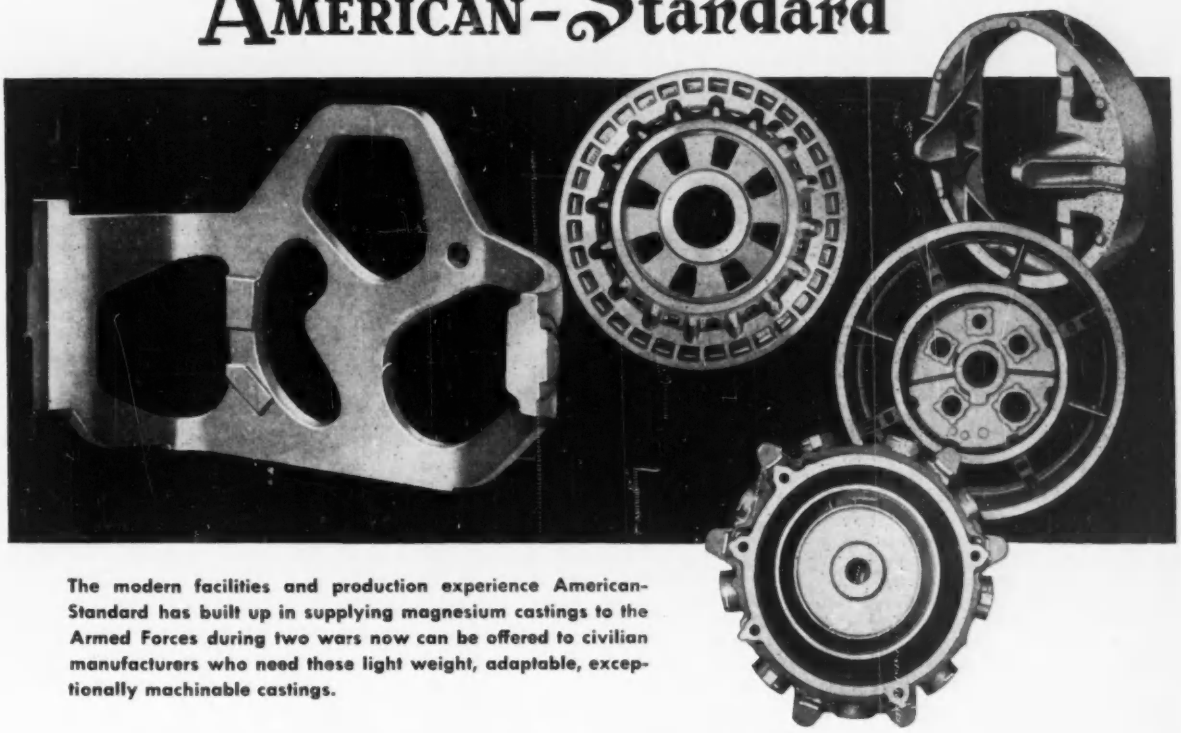

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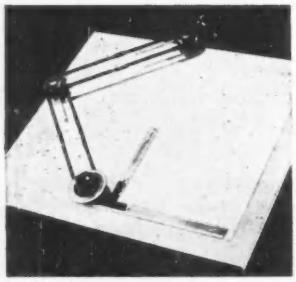

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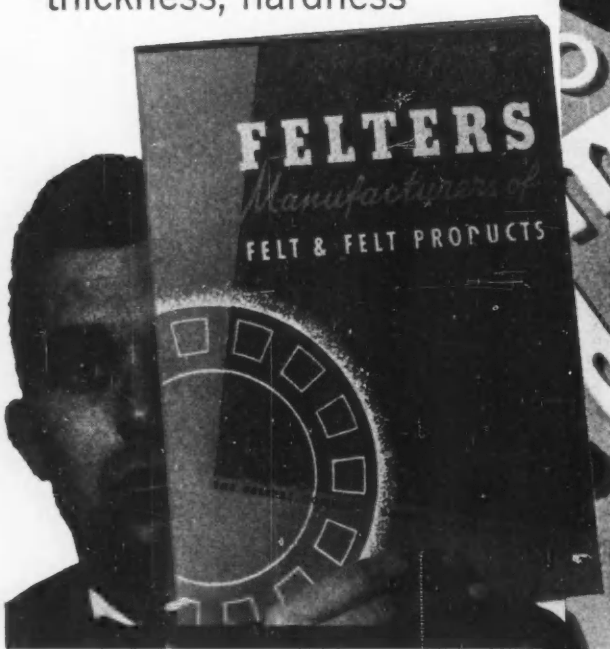

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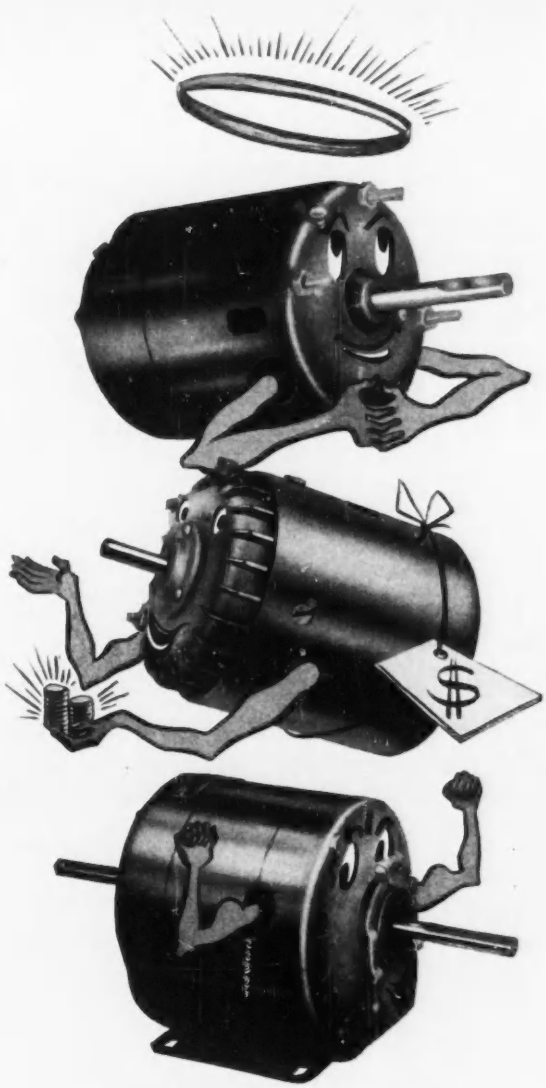

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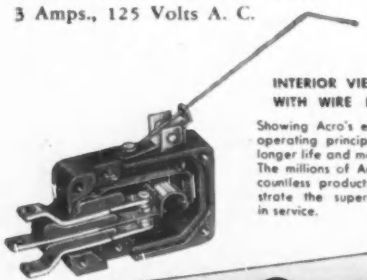

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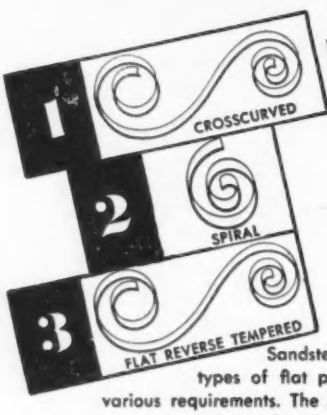

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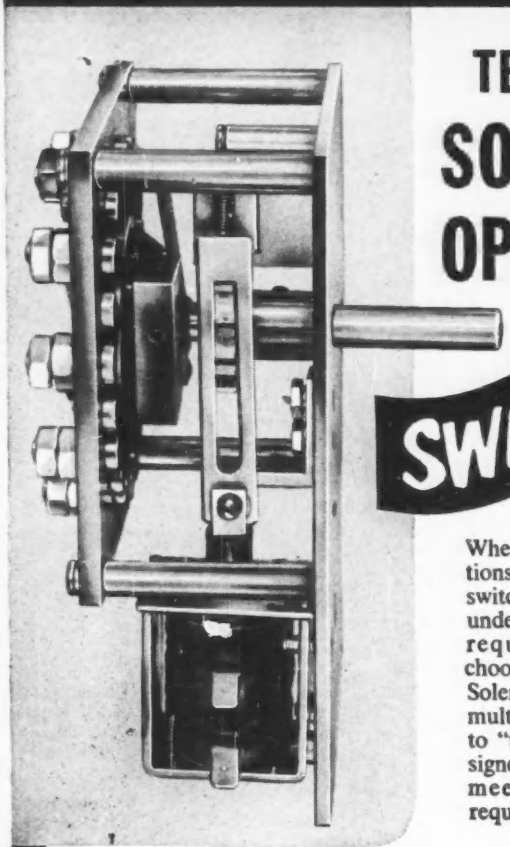

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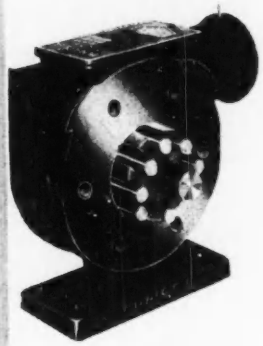

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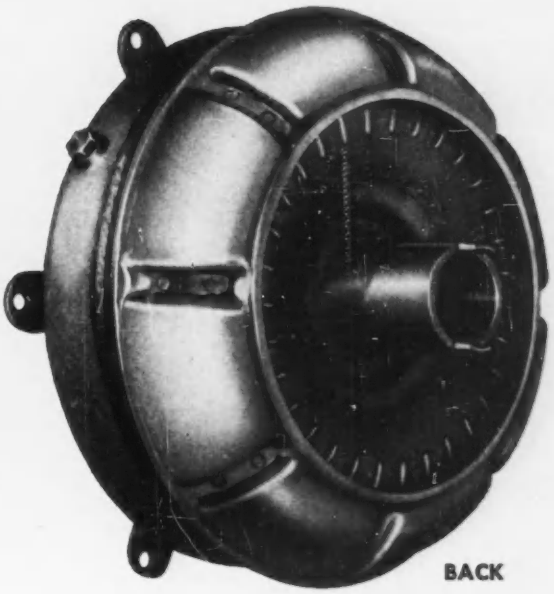

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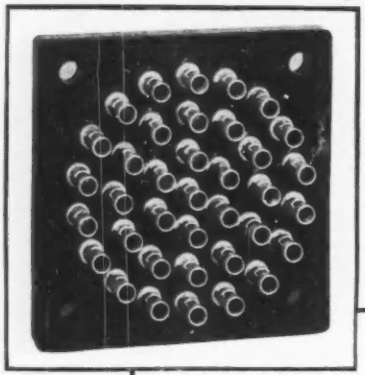
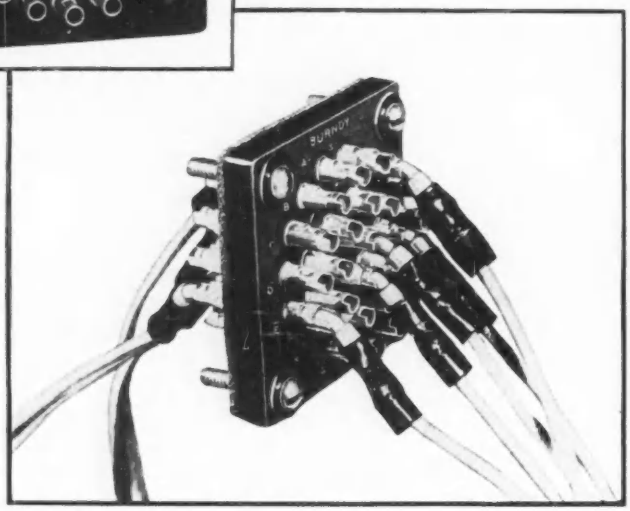


Burndy disconnect panels for pressurized bulkheads have molded in silver-plated socket assemblies for fast, sure connections. Burndy panels are available in many socket multiples and sizes, interchangeable with standard AN connector shell sizes. Silver-plated connector pins accommodate circraft wire sizes AN-20 through AN-00.



Here's a splendid example of accurate molding to exact specifications. Note the quantity of inserts. Here is a case where experience and skill are of the utmost importance . . . These disconnect panels are used in aircraft where failure could mean disaster. Kuhn & Jacob service includes design, die making and molding, all closely coordinated under one roof. That is why K & J molding service can mean so much to you.

ESTABLISHED 1919

KUHN & JACOB MOLDING & TOOL CO.

1230 SOUTHARD ST., TRENTON 8, N. J.

CONTACT THE K & J REPRESENTATIVE NEAREST YOU

S. C. Ullman, 55 W. 42nd St., New York, N. Y.
Telephone—Penn 6-0346

Wm. T. Wyler, Box 126, Stratford, Conn.
Telephone—Bridgeport 7-4293

Wm. A. Chalverus
Carson Road, Princeton, N. J.

Is there any data available on elastic elongation of chains?

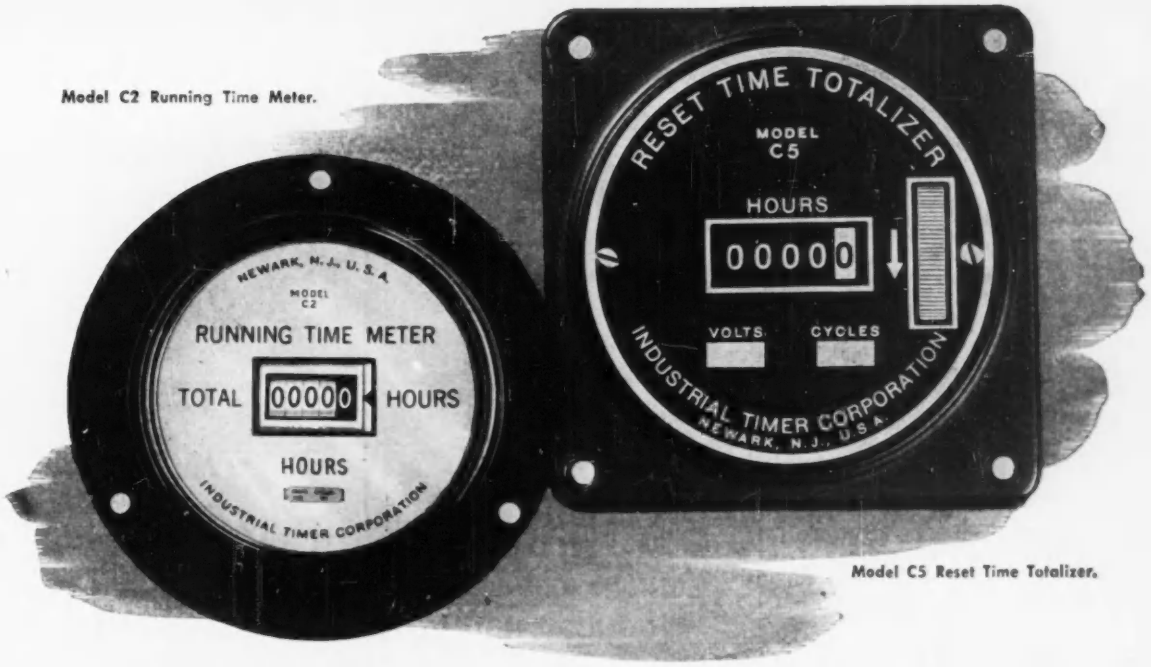
Actually, until very recently there has been little or no data available to designers regarding elastic elongation of various types of chains. A report in your *Annual HANDBOOK of Product Design for 1953*, however, for the first time outlines and shows in table and graph form the results of extensive tests to determine accurately the average elastic elongation of single strand ASA roller chain, double pitch conveyor chain, and cable chain.

The *HANDBOOK*, published for the first time last November, has earned the acclaim of design engineers everywhere for its abundance of up-to-the-minute and lastingly useful product engineering data. All the vital information in the *HANDBOOK* is separated into ten major classifications and fully indexed so that you can easily find exactly the data you particularly want. For example, the report mentioned above, titled "Elastic Elongation of Chains," is found in the section on *Power Transmission*.

Another edition will be along to join your '53 *HANDBOOK* in November. *The Annual HANDBOOK of Product Design for 1954* will present an even broader, more informative selection of data important to you in your work. Again, you'll receive the *HANDBOOK* with your regular subscription to *Product Engineering*, at no extra cost.

Product Engineering

330 West 42nd Street
New York 36, N. Y.



Model C2 Running Time Meter.

Model C5 Reset Time Totalizer.

NOW BOTH! Reset and Non-Reset Elapsed Time Meters

For applications where it may be desirable to reset to zero at any time, Industrial Timer now offers Reset Time Totalizers, in addition to its Running Time Meters.

SYNCHRONOUS MOTOR DRIVEN. Both types of elapsed time meters provide you with an exact record of machine hours on A.C. operated machines... up to 100,000 hours with "electric clock" running accuracy. Both utilize heavy duty synchronous motors that are self lubricating for long life. And both are available in enclosed and open type models. Running Time Meters are enclosed in black bakelite cases. Reset Time Totalizers in steel housings with baked black finish.

WIDE VARIETY OF APPLICATIONS. These Industrial Elapsed Time Meters permit you to compute readily production costs on A.C. operated machines — predict replacements for equipment of predetermined life expectancy. They can be used in a wide variety of applications such as: radio transmitters, vacuum tube devices, refrigerators, oil burners, molding machines, life test equipment, diesel generators, conveyors and many other types of machinery and equipment. For technical data, request Bulletin 88-53.

Reset Time Totalizer — Model Designations

CASED	OPEN	COUNT	RANGE	VOLTAGES	CYCLES
C 5		1/10 hr.	10,000 hrs.	115,220	60,50,25
	C 7	1/10 hr.	10,000 hrs.	115	60,50,25
C 5A		1 hr.	100,000 hrs.	115,220	60,50,25
	C 7A	1 hr.	100,000 hrs.	115	60,50,25

Running Time Meters — Model Designations

CASED	OPEN	COUNT	RANGE	VOLTAGES	CYCLES
C 2		1/10 hr.	10,000 hrs.	115,220,440	60,50,25
	C 4	1/10 hr.	10,000 hrs.	115	60,50,25
C 2A		1 hr.	100,000 hrs.	115,220,440	60,50,25
	C 4A	1 hr.	100,000 hrs.	115	60,50,25
C 2D		1/10 min.	10,000 min.	115,220,440	60,50,25
	C 4D	1/10 min.	10,000 min.	115	60,50,25
C 2F		1 min.	100,000 min.	115,220,440	60,50,25
	C 4F	1 min.	100,000 min.	115	60,50,25

MANUFACTURERS OF THESE AND OTHER TIMERS AND CONTROLS FOR INDUSTRY — CAM TIMERS • TIME DELAY TIMERS • AUTOMATIC RECYCLING TIMERS MANUAL SET TIMERS • INSTANTANEOUS RESET TIMERS.

Timers that Control The Pulse Beat of Industry

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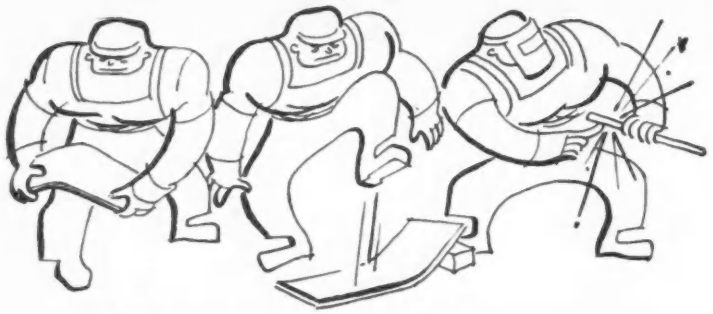

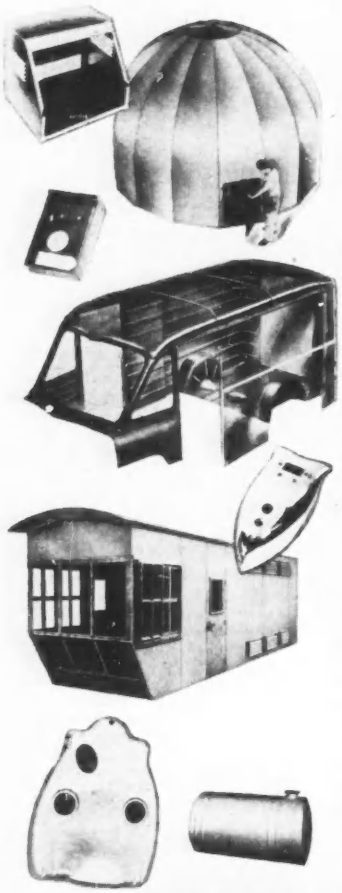

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CHARLES T. BRANDT, INC. Baltimore 30, Md.

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. . . Whose one job is to expedite delivery of your requests for "New Catalogs and Bulletins" to the manufacturers concerned.

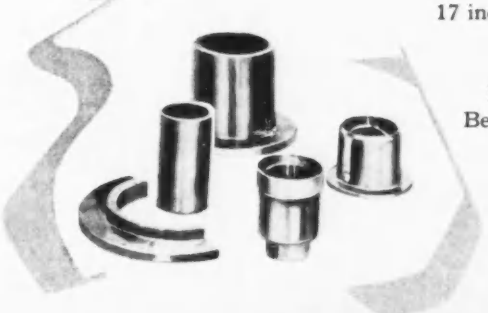
The job keeps her busy, too. She handles several thousand requests from Product Engineering readers every month. And she's anxious to be of service to you whenever she can.

So check the "New Catalogs and Bulletins" insert if you haven't already done so. You'll find a lot of useful information listed there . . . and any of it is available to you promptly and without cost.

Product Engineering

Johnson

CAST BRONZE BEARINGS HAVE UNTOLD APPLICATIONS



There are thousands of applications where sleeve bearings cast from bronze alloys are the most practical, serviceable and economical. For over fifty years Johnson Bronze has been recognized as an outstanding source of supply for these bearings. Every month an immense quantity of cast bronze bearings is produced . . . in numerous styles and in a great range of sizes. Tiny bearings, ¼ inch or less in diameter, to "king size" bearings, 14 inches OD and 17 inches in length, are included in this huge production. Over 900 sizes of Johnson General Purpose GP Bearings are available from distributors' stocks; likewise a wide selection of Graphited Cast Bronze Bearings and over 340 EM Electric Motor Bearings. For special applications, Johnson engineers will gladly consult with you on style of bearing and alloy best suited and, if necessary, will help you design the bearing best suited to your needs.

JOHNSON BRONZE COMPANY
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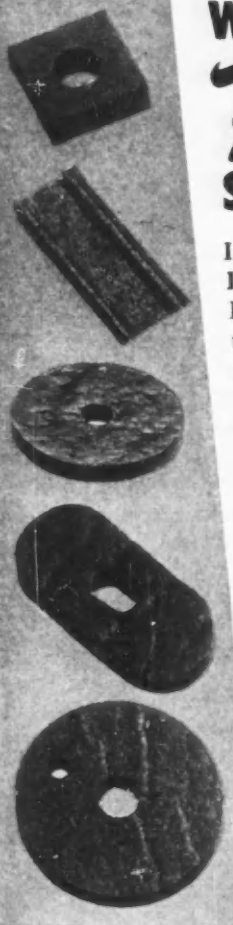
Sleeve-Type

JOHNSON BRONZE PRODUCES ALL TYPES OF SLEEVE BEARINGS: CAST BRONZE, plain or graphited • BRONZE-ON-STEEL, copper lead • STEEL BACK, babbitt lined • BRONZE BACK, babbitt lined • SHEET BRONZE, plain or graphited • CAST ALUMINUM • ALUMINUM-ON-STEEL • LEDALOY, powder metallurgy

Sleeve Bearing Headquarters since 1901

UNEXCELLED



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does not use felt in
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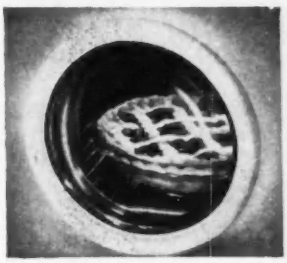
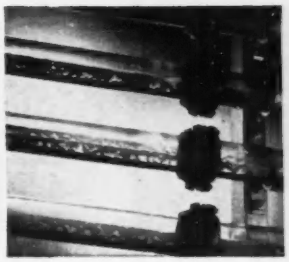
8 properties of glass to help you make better products



1 Transparency

You can let customers see inside your product through glass. A good example is the PYREX brand oven window that *stays* crystal clear.

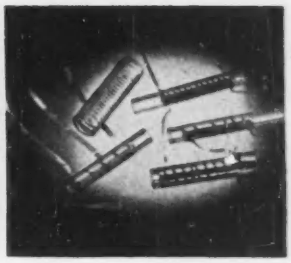


2 Corrosion Resistance

If your product must cope with corrosive liquids or atmospheres, glass will improve its operation, lengthen its life. It's the world's most corrosion-resistant material. The severe service PYREX brand pipe stands in chemical plants illustrates the point.

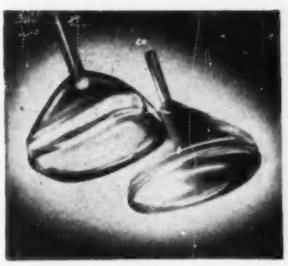
3 Heat Resistant

Don't rule out glass where your problem is heat, or quick switches from hot to cold. PYREX brand glass No. 7740 will stand temperatures from below zero to 250° F., while VYCOR brand glass goes up to 1800° F.



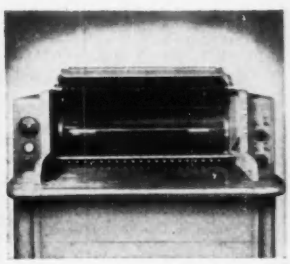
4 Electrical Stability

Glass components may provide such properties as low power factor, low temperature coefficient of capacitance and inductance.



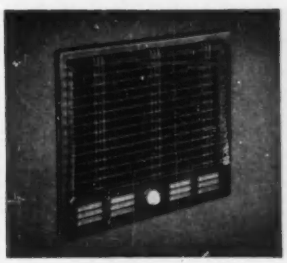
5 Hermetic Enclosure

Glass forms perfect glass-to-glass or glass-to-metal seals for vacuum-tight applications. Vacuum bottles are a good example. So are TV tubes and sealed beam headlights.



6 Light Transmission

Glass can accurately control and transmit light with permanent reliability. Good examples are all around you but one rather unusual one is the glass cylinder in this printing machine. It transmits the ultraviolet rays produced by a mercury arc lamp.



7 Heat Generation

Although you normally think of glass as an electrical insulator, Corning's E-C glass conducts electricity and radiates heat. E-C glass is ideal for space heaters, dryers, and other applications especially where an *even* heat distribution is wanted.

8 Photosensitivity

Designs reproduced photographically in Corning's special photosensitive glass cannot fade or wear off. They are ideal for permanently reproducing nameplates, photographs, artwork and offer a variety of design possibilities.

These eight properties give you only an indication of the versatility of glass by Corning.

This remarkable material can be made extra strong or weak, to conduct electricity or act as an insulator, to pass light or cut it off in virtually any size, shape or color you need.

It may pay you well, in terms of better operating characteristics, lower production costs, and extra sales points for your product, to consult Corning engineers before you reach the blueprint stage. For further information, just mail the coupon or write for a copy of, *"GLASS—its increasing importance in product design."*

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Corning means research in Glass

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Please send me your 12-page illustrated booklet, "GLASS, its increasing importance in product design."

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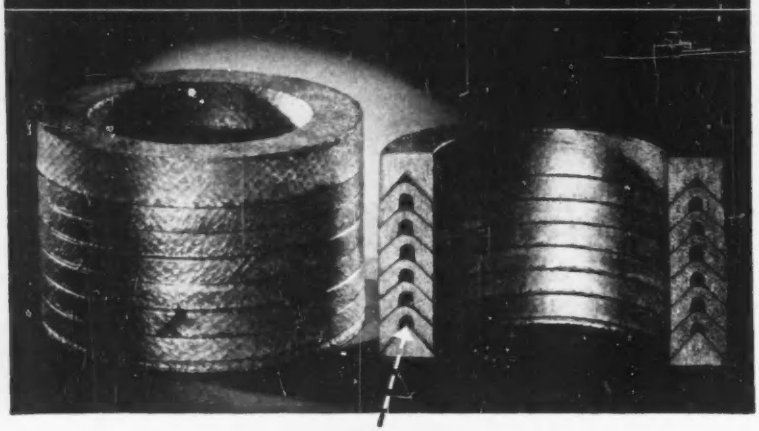
CHEVRON* PACKING



Exclusive hinge-like construction assures a positive, low-friction seal

At every pressure—from the lowest to the highest—Garlock CHEVRON packing provides a positive, low-friction seal. CHEVRON is ideally suited for use on hydraulic cylinders (both single-acting and double-acting), hydraulic rams, plungers of pumps and other reciprocating rods.

The exclusive hinge at the apex of each ring makes this packing flexible and sensitive to pressure changes. When the pressure is on, CHEVRON packing seals firmly both on the inside and outside edges. When the pressure is off, CHEVRON packing maintains a positive seal yet allows the ram or rod to return without binding. This automatic action not only prolongs the life of the packing but also increases the efficiency of the equipment on which it operates.

That is why many manufacturers of hydraulic cylinders, jacks, lifts and presses use Garlock CHEVRON packing exclusively.

Whether your job is plant maintenance or manufacturing new equipment, ask us about CHEVRON packing—the exclusive product of Garlock's own factories. Garlock CHEVRON packing is available in many materials such as: cotton duck with rubber or neoprene binder, asbestos with rubber or neoprene binder, hycar, "Teflon," and "Kel-F."

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

Branch Offices in Most Principal Cities

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GARLOCK

PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS, RUBBER EXPANSION JOINTS

WHY AND WHEN TO SPECIFY GEARS FORMED BY . . .

1. Powder Metallurgy
2. Casting
3. Extrusion
4. Cold Drawing
5. Plastic Molding

What production problems are solved by each of these five processes used in making precision gears? What are the advantages of each process—what are the limitations?

An eleven-page report, fully illustrated by charts and photographs, examines these five gear-forming processes in detail in your *Annual HANDBOOK of Product Design for 1953.*

Your *Annual HANDBOOK* presents each year significant developments and useful data extending to virtually every subject area in the field of product-design engineering. The *HANDBOOK* is conveniently sectionalized into ten major subject classifications, enabling you to find exactly the information you want on any subject quickly. The report on gear-forming processes mentioned above, for example, is found in the section on *Fabrication and Production Processes.*

In November, you will receive the *HANDBOOK for 1954.* The new *HANDBOOK* will be even bigger and more informative than the tremendously popular *HANDBOOK for 1953.* And it's part of your regular subscription to *Product Engineering!*

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Here's why SKF Triple-Seal "SAF" Pillow Blocks are your solution:

- SKF Triple-Seal "SAF" Pillow Blocks are easy to install and inspect.
- The Triple-Seal rotating rings provide effective sealing from dirt; retains any kind of lubricant.
- The bearings are self-aligning.
- Available with ball bearings or spherical roller bearings, free or held . . . for either adapter mounting or direct mounting of bearing on shaft.

When you have a bearing replacement to make, call your SKF Distributor. He'll show you *why* you will minimize bearing trouble with SKF Triple-Seal "SAF" Pillow Blocks. Remember—your SKF Distributor is a bearing *specialist*.

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manufacturers of SKF *and* HESS-BRIGHT *bearings.*

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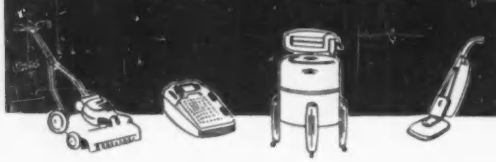
BALL AND ROLLER BEARINGS

SKF'S COMPLETE LINE OF ANTI-FRICTION BEARINGS, PLUS SKF ENGINEERING CO-OPERATION, HELPS YOU PUT *THE RIGHT BEARING IN THE RIGHT PLACE.*

MOTORS

• Built for YOUR job
• Built for economy
• Built for dependability

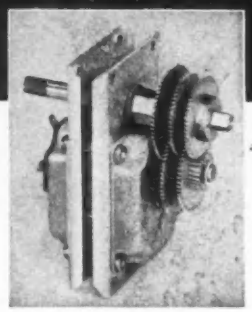


Whatever your product, if you have an application that calls for a rugged, always reliable source of fractional h.p., you'll want to work with EEPCO engineers.

Out of the tremendous variety of power problems solved by EEPCO has come a reputation for compact, workable design that is unsurpassed in industry. Concentration has always been on providing a power source that easily meets the product's requirements . . . that is efficient and economical under all condition of service.

Of course, we'll work to your specifications, or will be glad to furnish you with our complete engineering service for new designs to help improve your product's performance.

Check with EEPCO today.



EEPCO INGENUITY AT WORK

This is an EEPCO-designed reversible motor with gear train added to obtain desired reduction where low speed and high torque are required. Adapted for both continuous and intermittent operation, this Model AC-490-C motor weighs only 10 ounces and is precision-made for durability.

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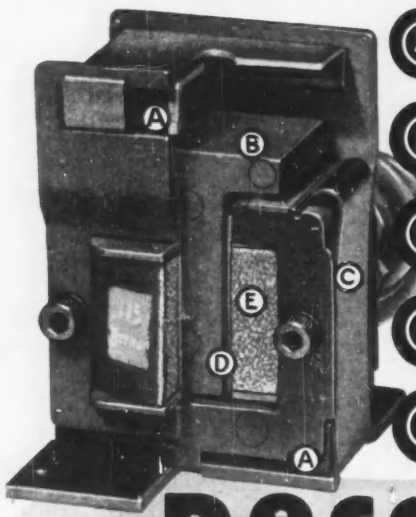
• P-M DC MOTORS & GENERATORS • CAPACITOR TYPE MOTORS • UNIVERSAL MOTORS
• DC MOTORS & GENERATORS • SHADED POLE MOTORS 2-4-6 Pole • P-M AC GENERATORS



(A) Shock-absorbing bumpers cushion stroke, assure longer service life.

(B) Silicon steel laminations give high efficiency.

(C) Tempered steel spring absorbs vibration — holds assembly firmly in alignment.

(D) Hardened beryllium-copper plunger guide reduces friction and wear.

(E) Heavy Formvar insulated magnet wire on high flow point molded nylon bobbin.

Decco INDUSTRIAL SOLENOIDS

Built better for longer service.
Shock mounted to reduce self-destruction.
Designed to meet J. I. C. specifications.
Four to twenty pounds—push or pull.
Stroke to one inch maximum.
A. C. or D. C. models.

Special solenoid problems engineered to your needs.

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8 pages — 20 cents a copy

In line with the rising use of porcelain enamel coatings for a steadily increasing variety of products, there are now hundreds of formulations available for many different property requirements . . . in practically any color you may want.

This Special Editorial Report contains invaluable information on types of porcelain enamel coatings, application methods, properties, and base-metal design factors. It is one of *Product Engineering's* brilliant series of full-color reports on product improvement through better surface appearance and protection.

Copies of other reports in this series are also available.

WHICH COATING FOR GRAY IRON?
8 pages — 25 cents a copy

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McGraw-Hill Building,
New York 36, N. Y.

Half mile of HELIARC TRADE MARK welds OK'D by rigid X-ray tests

A midwest manufacturer was faced with the problem of getting X-ray quality welds in aluminum vessels. These welds were subject to pressure and had to be entirely free from porosity and oxide inclusions. After thoroughly investigating customer specifications, LINDE's service engineers recommended HELIARC inert gas shielded welding for the job.

Since then, about a half mile of these HELIARC welds have been OK'd by 100% X-ray inspections. According to company officials, HELIARC welding was "perfect for the job" and meant real savings by getting X-ray quality welds the first time without expensive rejections or repairs.

Whether you weld aluminum or other hard-to-weld metals, you, too, will find that fast, clean, HELIARC welding will save you time and production costs. HELIARC welding takes place under a shield of inert argon gas which eliminates the need for flux. As a result, HELIARC welds are free from porosity and oxide inclusions. This means fewer rejects and lower finishing costs. In fact, spatter-free HELIARC welds in many cases can be left "as welded."

You owe it to yourself and to your Company to find out more about the cost saving benefits of HELIARC welding. Call your local LINDE representative today. He will be glad to furnish you with detailed information on HELIARC welding.

LEFT Welding heavy aluminum sections with HELIARC *HW-10 torch. These welds were strong, dense, and required little finishing. BELOW The 300 amp.* HELIARC *torch has all-internal water-cooling of both torch head and power cable for cool, long-lasting operation. The HW-10 also features quick electrode adjustment.*

Linde TRADE-MARK

LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N.Y. UCC Offices in Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

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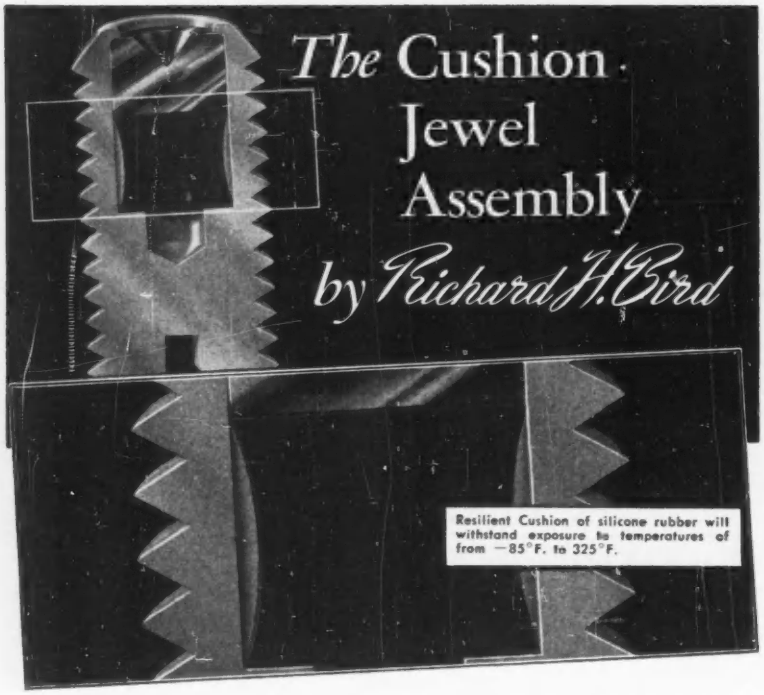
...an entirely new concept of jewel mounting for shock protection


The Cushion Jewel Assembly
by Richard H. Bird
Resilient Cushion of silicone rubber will withstand exposure to temperatures of from −85°F. to 325°F.

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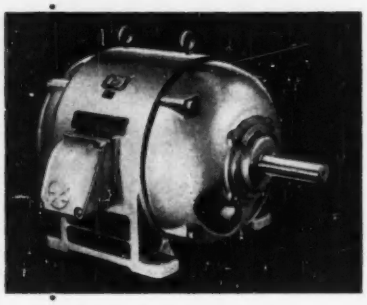

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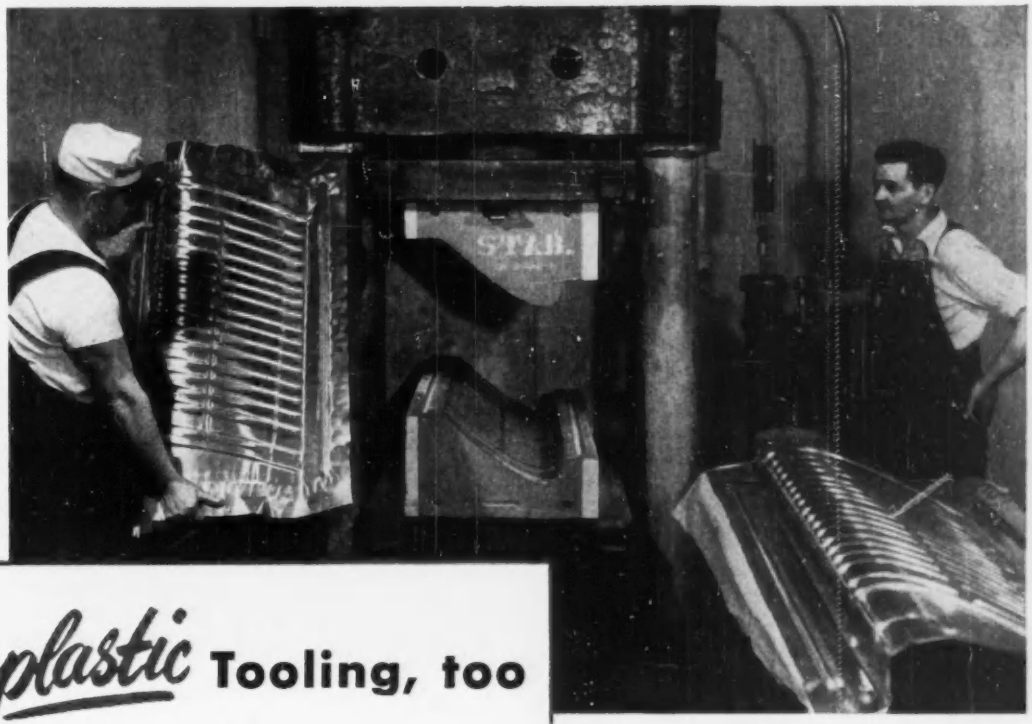

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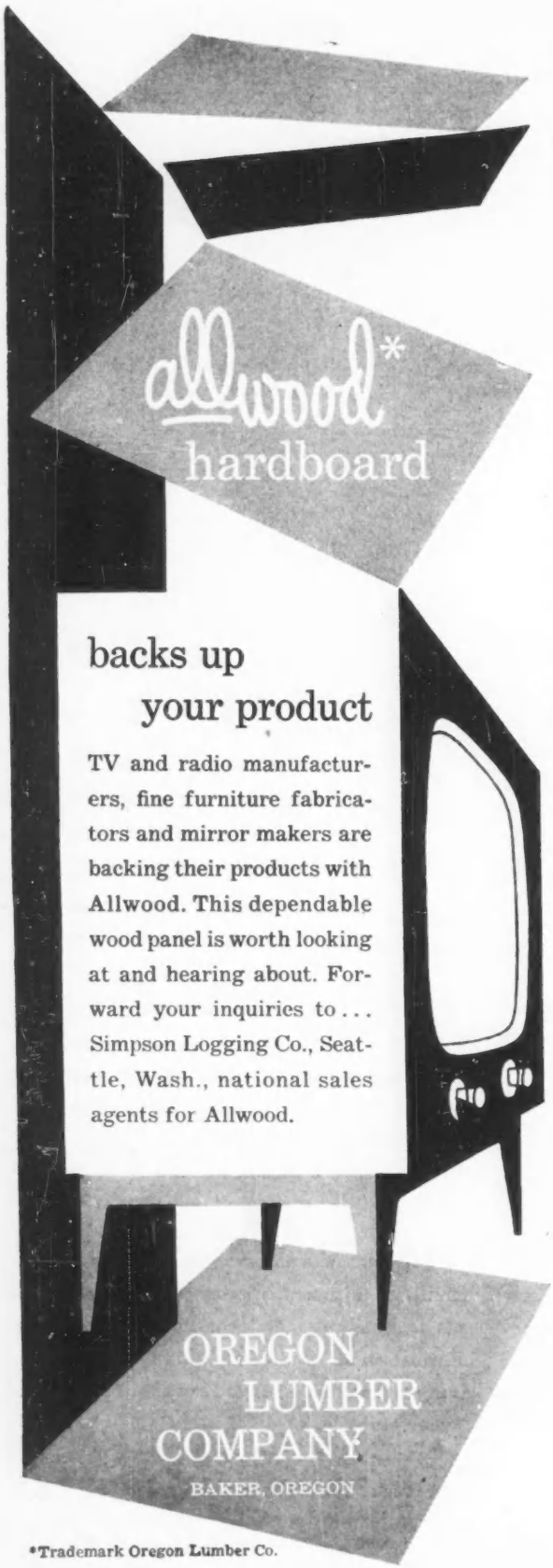
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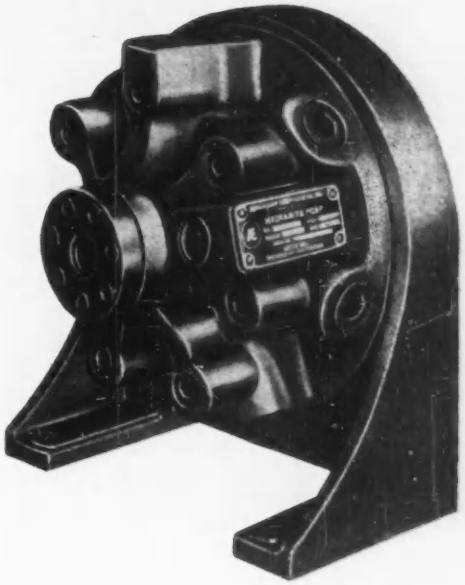

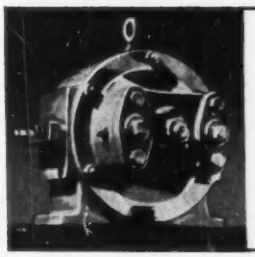

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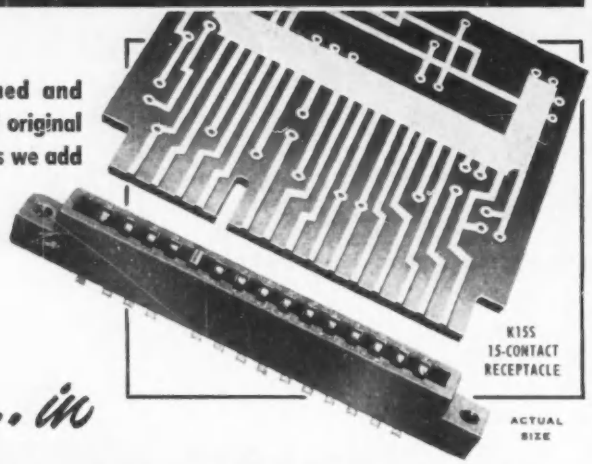

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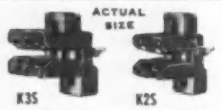

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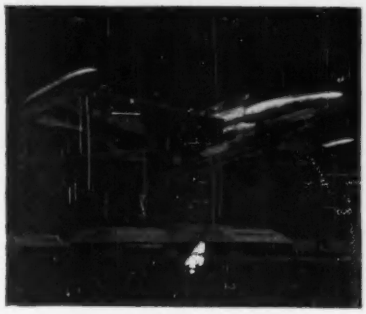

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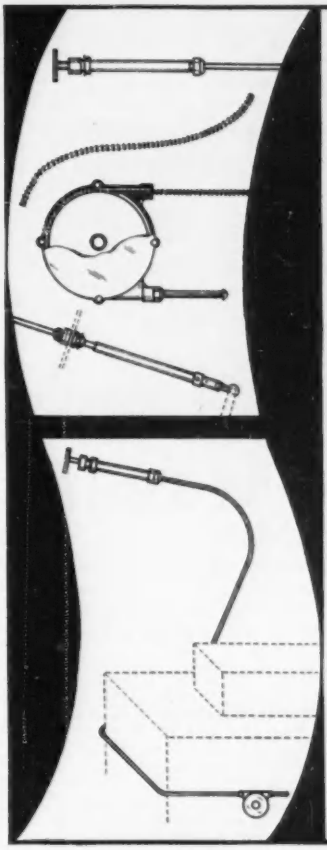

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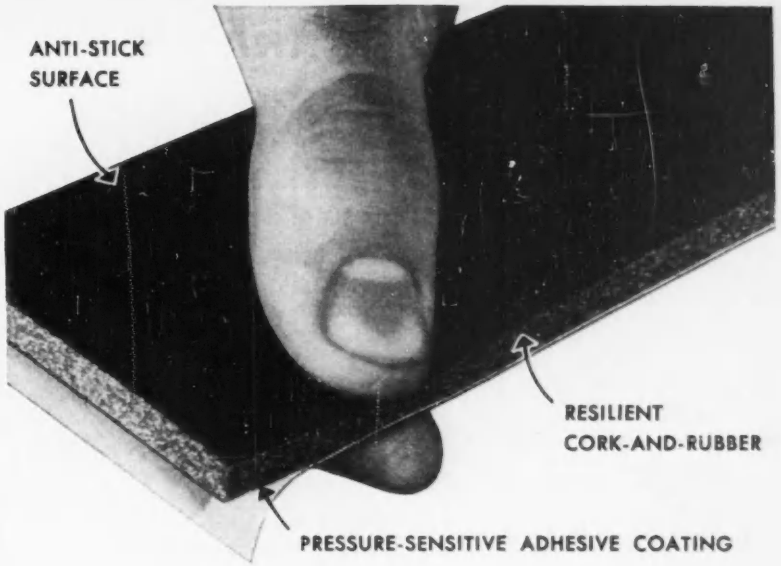

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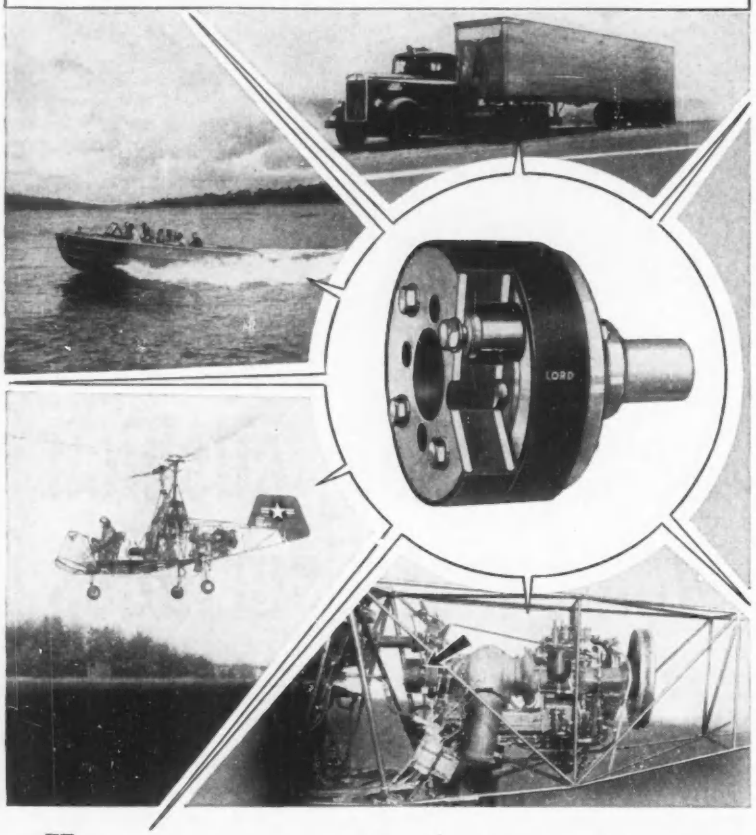

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Headquarters for VIBRATION CONTROL

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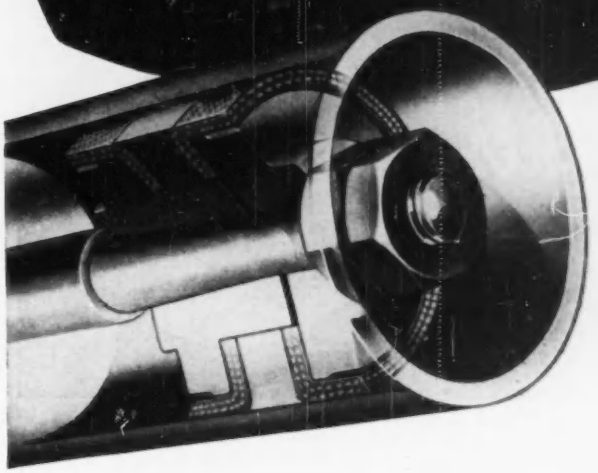

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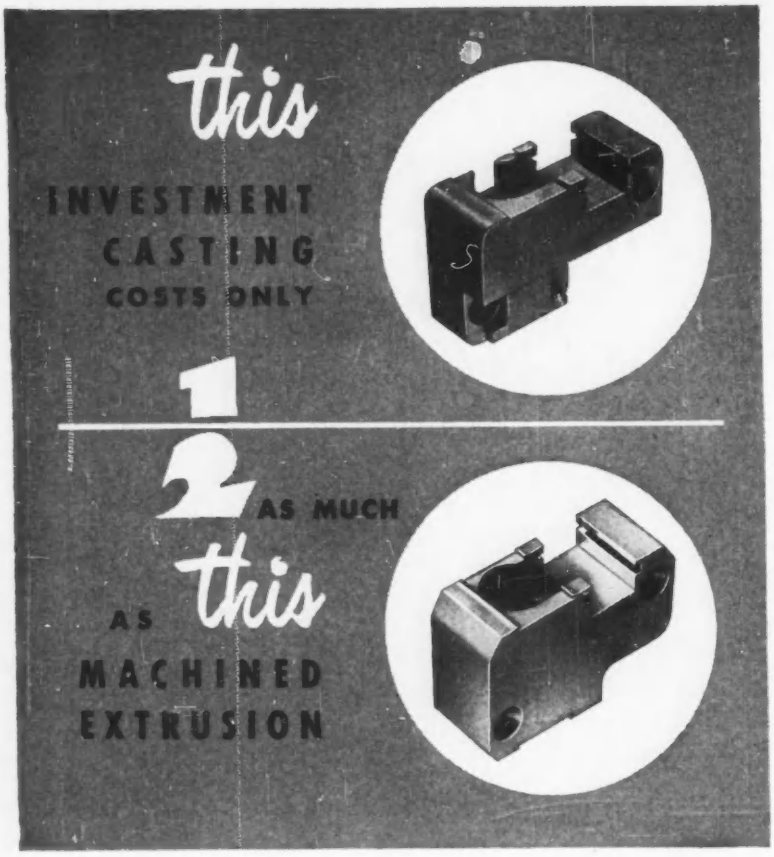

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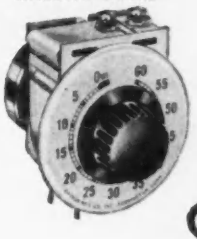
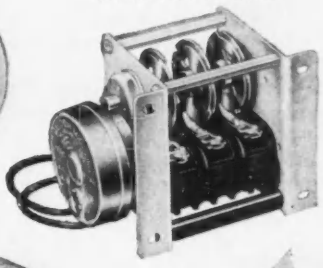
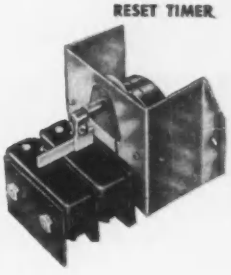


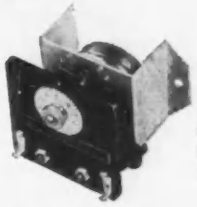
REPEAT CYCLE TIMERS



RESET TIMER



ELAPSED TIME INDICATORS



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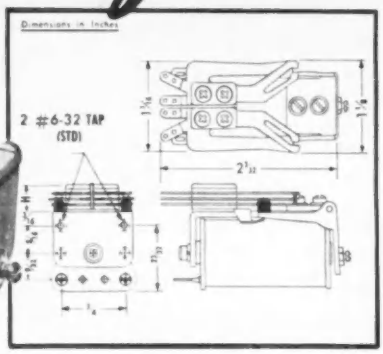

Type LS Relay

Available with single or double wound coils to 20,000 ohms.
Maximum of 20 springs in two pile-ups single or twin contacts.
Operating time — .002 sec. to .050 sec.
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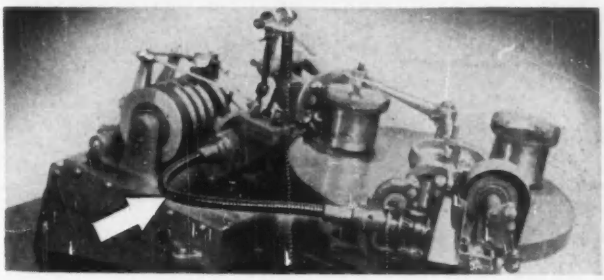

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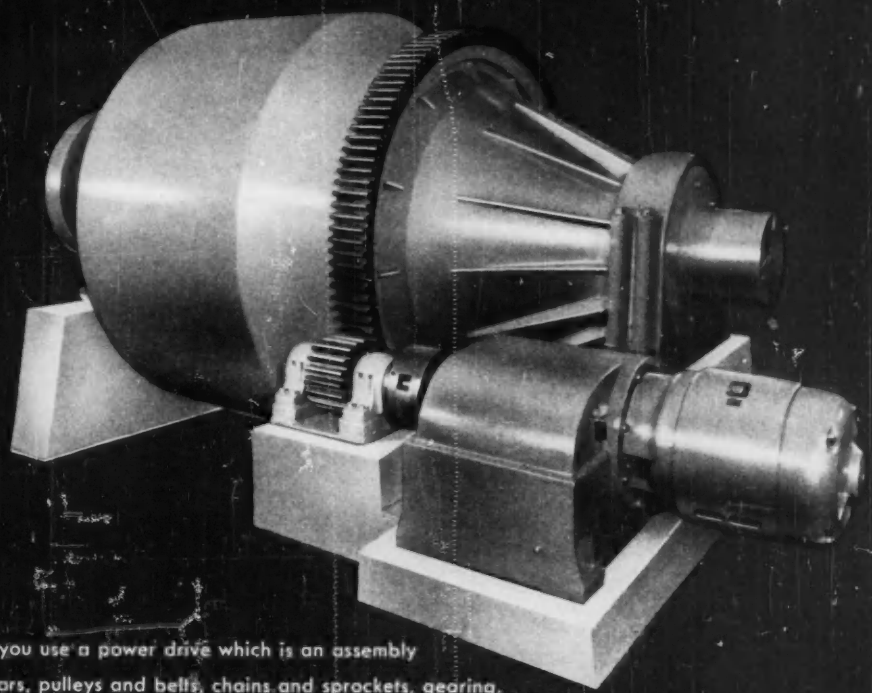

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